PATENT ABSTRACTS OF JAPAN

(11)Publication number : 08-128359

(43)Date of publication of application : 21.05.1996

(51)Int.Cl. F02M 25/07
F02D 41/02
F02D 41/04
F02P 5/15

(21)Application number : 06-294014

(22)Date of filing : 02.11.1994

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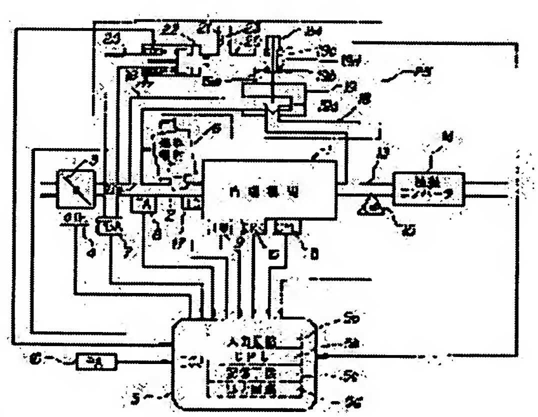
(54) EXHAUST GAS REFLUX RATE ESTIMATING DEVICE OF INTERNAL COMBUSTION ENGINE

(57)Abstract:

PURPOSE: To enhance eastimating accuracy of an exhaust gas reflux rate, and correct a fuel injection quantity or the ignition timing with high accuracy by finding wasteful time until exhaust gas flows in a combustion chamber by passing through an exhaust gas reflux valve, and calculating an exhaust gas reflux rate from an operating condition and a valve actuating condition.



CONSTITUTION: When an engine is operated, an ECU 5 searches a lift command value and a basic exhaust gas reflux rate correction factor by respective separate maps from engine rotating speed NE and intake air pressure PBA. Next, an exhaust gas reflux valve 19 is closed, and when the lift command value is not a lower limit value or less, the pressure ratio of the intake air pressure PBA to atmospheric pressure PA is found, and an EGR gas quantity A is found from its pressure ratio and the lift command value. An EGR gas quantity B is found from actual lift and the pressure ratio, and a reflux rate is estimated from an expression of (a reflux rate = a steady time reflux rate × B/A) with every operation period. A fuel injection correction factor is determined by selecting a past estimate corresponding to wasteful time until exhaust

gas enters a combustion chamber by passing through the exhaust gas reflux valve 19.

LEGAL STATUS

[Date of request for examination]	20.09.1999
[Date of sending the examiner's decision of rejection]	
[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]	
[Date of final disposal for application]	
[Patent number]	3268143
[Date of registration]	11.01.2002
[Number of appeal against examiner's decision of rejection]	
[Date of requesting appeal against examiner's decision of rejection]	
[Date of extinction of right]	

(19)日本国特許庁（JP）　(12) 公開特許公報（A）　(11)特許出願公開番号

特開平8－128359

(43)公開日　平成8年(1996)5月21日

(51)Int.Cl.⁶	識別記号	庁内整理番号	F I	技術表示箇所
F02M 25/07	550 E			
F02D 41/02	301 E			
41/04	330 Z			
F02P 5/15				
			F02P 5/15	G

審査請求　未請求　請求項の数6　FD　（全 13 頁）

(21)出願番号　特願平6－294014

(22)出願日　平成6年(1994)11月2日

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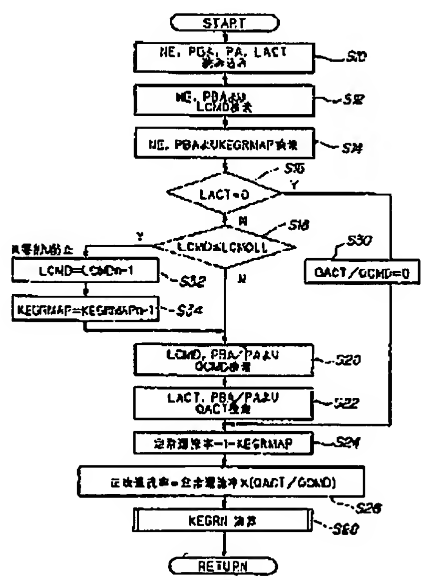
(54)【発明の名称】　内燃機関の排気還流率推定装置

(57)【要約】

【構成】　内燃機関の排気還流率の推定において、演算周期ごとに還流率＝定常時の還流率×（実リフトと弁前後の圧力比より求まるガス量）／（リフト指令値と弁前後の圧力比より求まるガス量）で推定して記憶しておくと共に、無駄時間に相当する過去の推定値を選択して現在の演算周期での排気還流率とみなし、燃料噴射補正係数を決定する。

【効果】　排気還流率の推定精度が向上すると共に、燃料噴射量ないし点火時期の補正を精度良く行うことができる。



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【特許請求の範囲】

【請求項1】 内燃機関の排気通路と吸気通路とを接続して排気ガスの少なくとも一部を前記吸気通路に還流する排気ガス還流通路と、該排気ガス還流通路を開閉する排気還流弁とを備えてなる内燃機関において、

a．所定の検出周期ごとに少なくとも機関回転数と機関負荷とを含む前記内燃機関の運転状態を検出する運転状態検出手段、

b．前記所定の検出周期ごとに前記排気還流弁の作動状態を検出する排気還流弁作動状態検出手段、

c．前記排気ガスが排気還流弁を通過して燃焼室に流入するまでの無駄時間を求め、検出された運転状態と排気還流弁の作動状態とから該無駄時間に相当する検出周期前の、前記排気還流弁を通過して燃焼室に流入する排気ガスの還流率を算出する排気還流率算出手段、および

d．該算出された排気還流率を前記内燃機関の燃焼室に流入する排気ガスの還流率とみなす排気還流率決定手段、を備えたことを特徴とする内燃機関の排気還流率推定装置。

【請求項2】 前記排気還流率算出手段は、

e．少なくとも機関回転数と機関負荷とから基本排気還流率を決定する基本排気還流率決定手段、

f．前記排気還流弁の流量特性に基づき、前記排気還流弁の開口面積検出値に応じて前記排気還流弁を通過する排気ガス量を推定する第1の推定手段、

g．前記排気還流弁の流量特性に基づき、前記排気還流弁の開口面積指令値に応じて前記排気還流弁を通過する排気ガス量を推定する第2の推定手段、および

h．前記第1、第2の推定手段で推定された排気ガス量の比を求め、該求めた比に応じて前記基本排気還流率を補正して前記内燃機関の燃焼室に流入する排気ガスの還流率を算出する算出手段、

からなることを特徴とする請求項1項記載の内燃機関の排気還流率推定装置。

【請求項3】 前記無駄時間が前記内燃機関の運転状態に応じて求められることを特徴とする請求項1項または2項記載の内燃機関の排気還流率推定装置。

【請求項4】 前記排気還流率決定手段は、前記排気還流率に応じて前記内燃機関の燃焼室に供給されるべき燃料噴射量を補正する補正係数を求める補正係数算出手段を備えることを特徴とする請求項1項ないし3項のいずれかに記載の内燃機関の排気還流率推定装置。

【請求項5】 前記排気還流率決定手段は、前記排気還流率に応じて前記内燃機関の点火時期を補正する補正係数を求める補正係数算出手段を備えることを特徴とする請求項1項ないし4項のいずれかに記載の内燃機関の排気還流率推定装置。

【請求項6】 前記排気還流率決定手段は、前記所定の検出周期に同期した演算周期ごとに予め算出される排気還流率および補正係数の少なくともいずれかを順次記憶する記憶手段を備え、前記無駄時間に応じて該記憶手段に記憶された前記排気還流率および前記補正係数の少なくともいずれかを選択することを特徴とする請求項1項ないし5項のいずれかに記載の内燃機関の排気還流率推定装置。

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【発明の詳細な説明】

【0001】

【産業上の利用分野】この発明は内燃機関の排気還流率推定装置に関し、より具体的には、機関燃焼室に流入する排気ガスの還流率を簡易かつ精度良く推定するようにした内燃機関の排気還流率推定装置に関する。尚、ここで「排気還流率」は、排気ガス／吸入空気の体積比ないしは重量比を意味する。

【0002】

【従来の技術】内燃機関の排気通路と吸気通路を接続する排気還流通路を設けて排気ガスの一部を前記吸気通路に還流させると共に、そこに排気還流弁を設けて還流量を制御し、NOxの低減と燃費の向上を図る排気還流制御において、排気還流制御を精度良く行うためには、実際に燃焼室に流入する排気ガスの還流率（以下「正味還流率」と言う）ないし排気還流量を正確に推定する必要がある。また、排気還流量は内燃機関の空燃比ないしは燃料噴射量を制御するときに外乱となることから、その意味でも排気還流率ないし排気還流量を精度良く推定する必要がある。

【0003】そこで、特開平4－311643号公報には、還流ガスの吸気通路への流入量から吸気通路の還流ガスと空気の分圧および全圧などを推定し、それから気筒への流入空気量を算出する手法が示されている。しかしながら、その手法では還流ガスの分圧を求めるために、還流ガスの吸気通路への流入量のみならず、吸気温度やチャンバ容積を正確に求める必要があり、複雑な計算を必要としている。そもそも還流ガスの動的な遅れもあって、還流ガスの吸気通路への流入量を正確に求めるのは、極めて困難である。

【0004】

【発明が解決しようとする課題】従って、この発明の目的は従来技術の上記した欠点を解消することにあり、複雑な計算や不確定な演算要素を極力低減し、簡易な構成でありながら、燃焼室に流入する排気ガスの還流率を精度良く求めるようにした内燃機関の排気還流率推定装置を提供することにある。

【0005】更には、燃焼室に流入する排気ガスは、空燃比が目標値となるように燃料噴射量を制御するとき、外乱となる。

【0006】従って、この発明の第2の目的は、複雑な計算や不確定な演算要素を極力低減し、簡易な構成でありながら、燃焼室に流入する排気ガスの還流率を精度良く求めて燃料噴射量を正確に補正するようにした内燃機関の排気還流率推定装置を提供することにある。

【0007】更には、燃焼室に流入する排気ガスは、混合気の着火性を低下させることから、点火時期制御においても外乱となる。

【0008】従って、この発明の第3の目的は、複雑な計算や不確定な演算要素を極力低減し、簡易な構成でありながら、燃焼室に流入する排気ガスの還流率を精度良く求めて点火時期を正確に補正するようにした内燃機関の排気還流率推定装置を提供することにある。

【0009】

【課題を解決するための手段】第1の目的を達成するために、この発明は請求項1項で、内燃機関の排気通路と吸気通路とを接続して排気ガスの少なくとも一部を前記吸気通路に還流する排気ガス還流通路と、該排気ガス還流通路を開閉する排気還流弁とを備えてなる内燃機関において、所定の検出周期ごとに少なくとも機関回転数と機関負荷とを含む前記内燃機関の運転状態を検出する運転状態検出手段、前記所定の検出周期ごとに前記排気還流弁の作動状態を検出する排気還流弁作動状態検出手段、前記排気ガスが排気還流弁を通過して燃焼室に流入するまでの無駄時間を求め、検出された運転状態と排気還流弁の作動状態とから該無駄時間に相当する検出周期前の、前記排気還流弁を通過して燃焼室に流入する排気ガスの還流率を算出する排気還流率算出手段、および該算出された排気還流率を前記内燃機関の燃焼室に流入する排気ガスの還流率とみなす排気還流率決定手段、を備える如く構成した。

【0010】請求項2項において、より具体的には、前記排気還流率算出手段は、少なくとも機関回転数と機関負荷とから基本排気還流率を決定する基本排気還流率決定手段、前記排気還流弁の流量特性に基づき、前記排気還流弁の開口面積検出値に応じて前記排気還流弁を通過する排気ガス量を推定する第1の推定手段、前記排気還流弁の流量特性に基づき、前記排気還流弁の開口面積指令値に応じて前記排気還流弁を通過する排気ガス量を推定する第2の推定手段、および前記第1、第2の推定手段で推定された排気ガス量の比を求め、該求めた比に応じて前記基本排気還流率を補正して前記内燃機関の燃焼室に流入する排気ガスの還流率を算出する算出手段、からなる如く構成した。

【0011】請求項3項において、より具体的には、前記無駄時間が前記内燃機関の運転状態に応じて求められる如く構成した。

【0012】第2の目的を達成するために、請求項4項において、前記排気還流率決定手段は、前記排気還流率に応じて前記内燃機関の燃焼室に供給されるべき燃料噴射量を補正する補正係数を求める補正係数算出手段を備える如く構成した。

【0013】第3の目的を達成するために、請求項5項において、前記排気還流率決定手段は、前記排気還流率に応じて前記内燃機関の点火時期を補正する補正係数を求める補正係数算出手段を備える如く構成した。

【0014】第1ないし第3の目的を達成するために、請求項6項において、より具体的には、前記排気還流率決定手段は、前記所定の検出周期に同期した演算周期ごとに予め算出される排気還流率および補正係数の少なくともいずれかを順次記憶する記憶手段を備え、前記無駄時間に応じて該記憶手段に記憶された前記排気還流率および前記補正係数の少なくともいずれかを選択する如く構成した。

【0015】

【作用】請求項1項にあっては、排気ガスが排気還流弁を通過して燃焼室に流入するまでの無駄時間を求め、検出された運転状態と排気還流弁の作動状態とから該無駄時間に相当する検出周期前の、前記排気還流弁を通過して燃焼室に流入する排気ガスの還流率を算出する排気還流率算出手段、および該算出された排気還流率を前記内燃機関の燃焼室に流入する排気ガスの還流率とみなす排気還流率決定手段、を備える如く構成したので、複雑な計算や不確定な演算要素を極力低減することができ、簡易な構成でありながら、燃焼室に流入する排気ガスの還流率を精度良く求めることができる。ここで、無駄時間は運転状態に応じて可変にしても良く、あるいは機関の構造に応じた固定値としても良い。

【0016】請求項2項においては、前記排気還流率算出手段は、機関回転数と機関負荷とから基本排気還流率を決定し、前記排気還流弁の流量特性に基づき、前記排気還流弁の開口面積検出値および指令値に応じて前記排気還流弁を通過する排気ガス量をそれぞれ推定し、それらの比から基本排気還流率を補正して前記内燃機関の燃焼室に流入する排気ガスの還流率を算出するように構成したので、換言すれば排気還流弁の流量特性から排気還流ガスの挙動を把握するので、複雑な計算や不確定な演算要素を極力減らすことができ、簡易な構成でありながら、実際に燃焼室に吸入される正味の排気還流率を精度良く推定することができる。

【0017】請求項3項にあっては、前記無駄時間が前記内燃機関の運転状態に応じて求められる如く構成したので、燃焼室に流入する排気ガスの還流率を一層的確に求めることができる。

【0018】請求項4項にあっては、前記排気還流率に応じて燃料噴射量を補正する補正係数を求めるように構成したので、複雑な計算や不確定な演算要素を極力減らすことができ、簡易な構成でありながら、実際に燃焼室に吸入される正味の排気還流率を精度良く推定することができ、それに基づいて燃料噴射量を適正に補正することができる。

【0019】請求項5項にあっては、前記排気還流率に応じて点火時期を補正する補正係数を求めるように構成したので、複雑な計算や不確定な演算要素を極力減らすことができ、簡易な構成でありながら、実際に燃焼室に

吸入される正味の排気還流率を精度良く推定することができ、それに基づいて点火時期を適正に補正することができる。

【００２０】請求項６項にあっては、演算周期ごとに予め算出される排気還流率および補正係数の少なくともいずれかを順次記憶し、前記無駄時間に応じて該記憶手段に記憶された前記排気還流率および前記補正係数の少なくともいずれかを選択するように構成したので、燃焼室に流入する排気ガスの還流率ないしは燃料噴射補正係数をより簡易に求めることができる。尚、排気還流率ないしは補正係数の算出に必要な運転状態検出値などを記憶しておき、無駄時間に応じて選択し、選択した値に基づいて排気還流率ないしは燃料噴射補正係数を始めて求めるようにしても良い。

【００２１】

【実施例】以下、添付図面に即してこの発明の実施例を説明する。

【００２２】図１はこの発明に係る内燃機関の排気還流率推定装置を示す全体構成図である。内燃機関は例えば４気筒の内燃機関であり、機関本体１の吸気管（吸気通路）２の途中にはスロットル弁３が設けられる。スロットル弁３にはスロットル位置θＴＨを検出するスロットル位置センサ（θＴＨで示す）４が連結され、出力を電子制御ユニット（以下「ＥＣＵ」と言う）５に供給する。

【００２３】ＥＣＵ５はスロットル位置センサ４および後述のセンサ群からの入力信号波形を整形し、電圧レベルを所定レベルに修正し、アナログ信号をデジタル信号値に変換するなどの機能を有する入力回路５ａ、ＣＰＵ５ｂ、ＣＰＵ５ｂで実行される各種演算プログラムおよび演算結果などを記憶する記憶手段５ｃ、および出力回路５ｄなどからなる。

【００２４】燃料噴射弁６は機関本体１とスロットル弁３との間で、かつ燃焼室（図示せず）の吸気ポート（図示せず）の上流側に気筒ごとに設けられる。燃料噴射弁６は燃料ポンプ（図示せず）に接続されると共に、ＥＣＵ５に電気的に接続される。一方、スロットル弁３の下流には吸気管内圧力ＰＢＡを絶対圧力で検出する絶対圧センサ（ＰＢＡで示す）７が設けられると共に、その下流には吸気温ＴＡを検出する吸気温センサ（ＴＡで示す）８が設けられる。これらセンサの出力もＥＣＵ５に送出される。

【００２５】また機関本体１には機関冷却水温ＴＷを検出する水温センサ（ＴＷで示す）９が設けられると共に、クランク軸ないしはカム軸（共に図示せず）にはＴＤＣ位置を含む所定のクランク角度ＣＲＫを検出するクランク角センサ（ＣＲＫで示す）１０と、特定気筒の所定クランク角度ＣＹＬを検出する気筒判別センサ（ＣＹＬで示す）１１が設けられる。これらセンサの出力もＥＣＵ５に送出され、カウンタ（図示せず）を介してクランク角センサ出力ＣＲＫをカウントして機関回転数ＮＥを検出する。

【００２６】また機関本体１の排気管（排気通路）１３には触媒コンバータ１４が配置されており、排気ガス中のＨＣ，ＣＯ，ＮＯｘ成分などを浄化する。触媒コンバータ１４の上流には排気ガス中の酸素濃度を理論空燃比を中心としてリッチからリーンにわたる広い範囲で検出する広域空燃比センサ（ＬＡＦで示す）１５が装着され、出力をＥＣＵ５に供給する。

【００２７】更に、機関本体１の付近には大気圧ＰＡを検出する大気圧センサ（ＰＡで示す）１６が設けられると共に、吸気ポート付近の吸気管２の壁面にはその壁温ＴＣを検出する壁温センサ（ＴＣで示す）１７が設けられる。これらセンサの出力も、ＥＣＵ５に供給される。

【００２８】次に、排気還流機構２５について説明する。

【００２９】排気還流通路２５は、排気管１３を吸気管２に接続する排気還流通路１８を備える（符号１８ａは、吸気管側の開口端を示す）。排気還流通路１８の途中には排気還流弁（ＥＧＲ弁）１９が設けられる。排気還流弁１９は負圧応動式であって、主として、通路１８を開閉できるように配置された弁体１９ａと、弁体１９ａに連結されて後述の電磁弁２２を介して導入される負圧により作動するダイアフラム１９ｂと、ダイアフラム１９ｂを閉弁方向に付勢するばね１９ｃとから構成される。

【００３０】ダイアフラム１９ｂにより画成される負圧室１９ｄには連通路２０が接続され、吸気管２内の負圧が、該連通路２０の途中に設けられた常閉型電磁弁２２を介して導入されるように構成される。大気室１９ｅは、大気に連通している。更に、連通路２０には電磁弁２２の下流で大気連通路２３が接続され、該連通路２３の途中に設けられたオリフィス２１を介して大気圧が連通路２０に、次いで前記負圧室１９ｄに導入されるように構成される。

【００３１】前記電磁弁２２はＥＣＵ５に接続され、ＥＣＵ５からの駆動信号によって作動し、排気還流弁１９の弁体１９ａのリフト動作（開弁動作）およびその速度を制御する。排気還流弁１９にはリフトセンサ２４が設けられており、弁体１９ａの作動量（リフト量）を検出し、出力をＥＣＵ５に送出する。また、ＥＣＵ５は燃料噴射量を算出し、前記燃料噴射弁６の開弁時間を介して機関燃焼室に供給するべき燃料噴射量を制御すると共に、点火時期を算出し、図示しない点火手段を介して機関燃焼室内の混合気を点火する。

【００３２】ここで、ＥＣＵ５は、以下に述べるように、排気還流率を推定し、推定値に基づいて燃料噴射量ないしは点火時期を補正する。

【００３３】図２は、その排気還流率の推定動作を説明するフロー・チャートである。

【００３４】同図の説明に入る前に、図３以下を参照してこの発明に係る推定動作のアルゴリズムを説明する。

【００３５】排気還流弁を通過するガス量は、弁単体としてみると、弁の開口面積と弁前後の圧力比、即ち、流量特性（設計諸元）によって決定される。即ち、弁の開口面積、即ち、リフト量と、弁の上下流圧力の比から求められると考えられる。

【００３６】実機においても図３に示すように、還流ガス量は、弁のリフト量と、前記大気連通路２３を介して作用する大気圧ＰＡと吸気管２の吸気圧力ＰＢＡとの比を求めることにより、ある程度まで推定可能と考えられる（実際には排気圧力や排気温度により流量特性が若干変化するが、その特性の変化は後述の如くガス量割合を用いることでかなりの程度まで吸収できると考えられる）。

【００３７】そこで、先ずこの点に着目し、流量特性に基づいて還流率を求めるようにした。尚、開口面積をリフト量から求めているが、これはリフト量が開口面積に対応する構造の弁を使用したためである。従って、リニヤソレノイドなど別の構造のものを使用するときは、別のパラメータから開口面積を求めることになる。

【００３８】ところで、還流率には定常時の還流率と過渡時の還流率とがあるが、そのうち定常時の還流率とはリフト指令値が実リフトと等しい状態の値であり、過渡時の還流率とは図４に示すように、リフト指令値が実リフトと等しくない状態の値である。そして、この発明に係るアルゴリズムでは、過渡時の差異は、図３に示すように、還流率がそれに対応するガス量割合分だけ、定常時の還流率からずれることによって生じた、と考えた。

【００３９】具体的には、定常時では

リフト指令値＝実リフト、ガス量割合＝１

即ち、

還流率＝定常時の還流率

【００４０】過渡時では

リフト指令値≠実リフト、ガス量割合≠１

即ち、

還流率＝定常時の還流率（マップ検索値）×ガス量割合

となる。

【００４１】このように、両ガス量の割合を定常時の還流率に乗じることで、燃焼室に流入する正味還流率が求められると考えた。式で示すと、以下の如くになる。

正味還流率＝（定常時の還流率）×（実リフトと弁前後の圧力比より求まるガス量ＱＡＣＴ）／（リフト指令値と弁前後の圧力比より求まるガス量ＱＣＭＤ）

【００４２】ここで、定常時の還流率は、還流率補正係数を求め、それを１から減算することで求める。即ち、定常時の還流率補正係数をＫＥＧＲＭＡＰと称すると、

定常時の還流率＝（１－ＫＥＧＲＭＡＰ）

で求める。

【００４３】尚、この明細書では定常時の還流率ないし定常時の還流率補正係数を基本排気還流率ないし基本排気還流率補正係数とも称する。また、定常時の還流率補正係数ＫＥＧＲＭＡＰは、機関回転数ＮＥと吸気圧力ＰＢＡとから予め実験で求めて図５に示すようにマップとして設定しておき、それを検索して求めるようにした。

【００４４】ところで、排気還流制御においては、機関回転数と機関負荷などから排気還流弁のリフト指令値を決定して行うが、図４に示すように、指令値に対して実リフト（リフト検出値）は遅れを持つ。更に、その開弁動作に応じて還流ガスが燃焼室に流入するにも遅れがある。

【００４５】そこで、本出願人は先に特願平５－１１８２３９号において、排気還流弁を通過した還流ガスの量の中、その制御サイクル中に燃焼室に流入した量の占める割合を直接率とし、それ以前に通過して燃焼室までの空間部位に滞留していてその制御サイクルに燃焼室に流入した量の占める割合を持ち去り率とする、還流ガスの挙動を記述するモデルを立て、それに基づいて正味還流率を推定する技術を提案した。

【００４６】しかしながら、還流ガスの挙動を更に考察した結果、排気還流弁を通過した還流ガスは、ある無駄時間が経過した後に、一度に燃焼室に流入すると考える方が、還流ガスの挙動を表現しやすいことが判明した。そこで、所定の周期ごとに前記した正味還流率を算出して記憶手段に格納しておくと共に、無駄時間に相当する過去の周期の算出値をもって真に燃焼室に流入した排気ガスの還流率とみなすようにした。

【００４７】以下、実施例に係る装置の動作を図２フロー・チャートに従って説明する。尚、このフロー・チャートに示されるプログラムは各ＴＤＣ位置で起動される。

【００４８】先ずＳ１０で機関回転数ＮＥ、吸気圧力ＰＢＡ、大気圧ＰＡ、実リフトＬＡＣＴ（リフトセンサ２４の出力）などを読み込み、Ｓ１２に進んで機関回転数ＮＥと吸気圧力ＰＢＡとからリフト指令値ＬＣＭＤを検索する。ここでリフト指令値ＬＣＭＤは、図６に示す如き、予め特性を定めて設定しておいたマップを検索して求める。

【００４９】続いてＳ１４に進んで機関回転数ＮＥと吸気圧力ＰＢＡとから前記した図５に示すマップを検索して基本排気還流率補正係数ＫＥＧＲＭＡＰを検索する。

【００５０】次いでＳ１６に進んで検出した実リフトＬＡＣＴが零ではないことを確認し、即ち、排気還流弁１９が開弁していることを確認してＳ１８に進み、検索したリフト指令値ＬＣＭＤを所定の下限値ＬＣＭＤ$_{LL}$（微小値）と比較する。

【００５１】Ｓ１８で検索値が下限値以下ではないと判断されるときはＳ２０に進み、そこで吸気圧力ＰＢＡと大気圧ＰＡとの比ＰＢＡ／ＰＡを求め、それと検索したリフト指令値ＬＣＭＤとから、図３に示す特性をマップ

化したもの（図示せず）を検索してガス量ＱＣＭＤを求める。これは先の数式に言う「リフト指令値と弁前後の圧力比より求まるガス量」である。

【００５２】続いてＳ２２に進み、検出した実リフトＬＡＣＴと同様の比ＰＢＡ／ＰＡとから同様に図３に示す特性をマップ化したもの（図示せず）を検索してガス量ＱＡＣＴを求める。これは先の数式で言う「実リフトと弁前後の圧力比より求まるガス量」に相当する。

【００５３】続いてＳ２４に進んで検索した基本排気還流率補正係数ＫＥＧＲＭＡＰを１から減算して得た値を定常還流率（基本排気還流率ないし定常時の還流率）とする。ここで、定常時の還流率とは前記の如く、排気還流動作が安定している際の還流率、即ち、排気還流動作が開始される、ないしは停止される際などの過渡的な状態にないときの還流率を意味する。

【００５４】続いてＳ２６に進み、図示の如く、定常還流率に値ＱＡＣＴ，ＱＣＭＤの比ＱＡＣＴ／ＱＣＭＤを乗じて正味還流率を求める。

【００５５】続いて、Ｓ２８に進んで燃料噴射補正係数ＫＥＧＲＮを演算する。図７はその作業を示すサブルーチン・フロー・チャートである。

【００５６】同図に従って説明すると、Ｓ１００において正味還流率（図２のＳ２６で求めたもの）を１から減算し、その値を燃料噴射補正係数ＫＥＧＲＮとする。

【００５７】続いてＳ１０２に進み、算出した燃料噴射補正係数ＫＥＧＲＮをリングバッファに格納（記憶）する。図８はそのリングバッファの構成を示す説明図であり、前記したＥＣＵ５の記憶手段５ｃに設けられる。

【００５８】リングバッファは図示の如く、ｎ個のアドレスを有し、各アドレスは０からｎまでの番号が付されて特定される。そして図２（および図７）フロー・チャートがＴＤＣで起動されて燃料噴射補正係数ＫＥＧＲＮが算出される度に、図において上方から順次格納（更新）される。

【００５９】続いてＳ１０４に進み、検出した機関回転数ＮＥと機関負荷、例えば吸気圧力ＰＢＡとからマップを検索して無駄時間τを検索する。図９はその特性を示す説明図である。

【００６０】即ち、前記した無駄時間は排気還流弁を通過した還流ガスが燃焼室に流入するまでの遅れ時間を示すが、それは機関回転数および機関負荷、例えば吸気圧力などに応じて変わるものである。ここで、無駄時間τは、より具体的には前記しバッファ番号で示される。

【００６１】続いてＳ１０６に進み、検索した無駄時間τ（より具体的にはバッファ番号）に基づき、相当するアドレスに格納された算出値（燃料噴射補正係数ＫＥＧＲＮ）を読み出す。即ち、図１０に示すように、現在時点がＡであるとき、例えば１２回前の算出値を選択し、それを今回の燃料噴射補正係数ＫＥＧＲＮとする。

【００６２】これを排気還流弁の動作から見ると、１２回前の燃料噴射補正係数ＫＥＧＲＮは１．０であり、そのことは排気還流弁が閉じられていたことを意味する。その後に燃料噴射補正係数ＫＥＧＲＮは例えば０．９９，０．９８などと徐々に小さくなり、換言すれば排気還流弁が開けられて現在時点Ａに至っているが、図示例の場合、現在時点では、還流ガスは未だ燃焼室に流入していないと判断し、従って燃料噴射の減少補正を行わないようにする。

【００６３】同時に、決定した燃料噴射補正係数ＫＥＧＲＮに基づいて燃料噴射量を補正する。この燃料噴射量の補正は、機関回転数と機関負荷とから求めた基本燃料噴射量Ｔｉｍに補正係数ＫＥＧＲＮを乗じて出力燃料噴射量Ｔｏｕｔを求めることで行うが、これ自体は公知なので、この程度の説明に止める。

【００６４】図２フロー・チャートに戻ると、尚、Ｓ１６で実リフトＬＡＣＴが零と判断されるときは排気還流は行われていないが、燃料噴射補正係数ＫＥＧＲＮは無駄時間τが経過した後の値から決定されるため、Ｓ２４以降に進んで正味還流率と燃料噴射補正係数ＫＥＧＲＮを算出する。この場合、Ｓ２６で正味還流率は０に、図７フロー・チャートのＳ１００で燃料噴射補正係数ＫＥＧＲＮは１．０に決定される。

【００６５】また、Ｓ１８でリフト指令値ＬＣＭＤが下限値ＬＣＭＤLL以下と判断されるときはＳ３２に進み、リフト指令値ＬＣＭＤは前回値ＬＣＭＤｎ－１をそのまま保持する（簡略化のため、このフロー・チャートで今回値にｎを付すのは省略した）。

【００６６】これは、排気還流を実行する領域から実行しない領域へ移行した際、リフト指令値ＬＣＭＤが零になっても、排気還流弁１９の動特性に遅れがあるため、実リフトＬＡＣＴは直ちに零にならないことから、リフト指令値ＬＣＭＤが下限値（関値）ＬＣＭＤLL以下の場合にはリフト指令値ＬＣＭＤを前回値ＬＣＭＤn-1（前回制御サイクル時n-1 のときの値）にホールドするようにした。この前回値ホールドは、Ｓ１６で実リフトＬＡＣＴが零になったことが確認されるまで行われる。

【００６７】また、リフト指令値ＬＣＭＤが下限値ＬＣＭＤLL以下のときはリフト指令値ＬＣＭＤが零である場合もあり、その際にはＳ２０でのＱＣＭＤ検索値も零となってＳ２６の演算で零割りが生じて演算不能となる。しかし、上記の如く前回値をホールドすることにより、演算不能となる恐れはない。尚、下限値ＬＣＭＤLLは微小値としたが、零でも良い。

【００６８】続いてＳ３４に進み、基本排気還流率補正係数ＫＥＧＲＭＡＰのマップ検索値（Ｓ１４で検索）を前回検索値ＫＥＧＲＭＡＰn-1 に置き換える。これは、Ｓ１２で検索されたリフト指令値ＬＣＭＤが下限値以下と判断される運転状態においては、Ｓ１４で検索される基本排気還流率補正係数ＫＥＧＲＭＡＰが、この実施例で予定する特性では１に設定されるため、Ｓ２４の演算

において定常還流率が０となる恐れがあるからである。

【００６９】この実施例は上記の如く、検出された機関回転数および機関負荷、例えば吸気圧力と排気還流弁の作動状態とから前記排気還流弁を通過して燃焼室に流入する排気ガスの正味還流率を演算周期ごとに算出し、それに基づいて燃料噴射補正係数を演算周期ごとに順次算出して記憶しておくと共に、排気ガスが排気還流弁を通過して燃焼室に流入するまでの無駄時間を求め、無駄時間に相当する演算周期の算出値を選択し、それを現在の演算周期での燃料噴射補正係数とみなすようにしたので、複雑な計算や不確定な演算要素を極力低減することができ、簡易な構成でありながら、燃焼室に流入する排気ガスの還流率を精度良く求めて燃料噴射量を精度良く補正することができる。

【００７０】更に、排気還流弁の流量特性に着目し、過渡時の還流率と定常時のそれの偏差はガス量割合であることに着目して機関燃焼室に流入する正味還流率を推定するようにしたので、簡易な構成でありながら、排気ガスの挙動を正確に把握することができる。また、ガス量割合を用いているため、ガス量に対する排気温度や排圧の影響をかなりの程度まで吸収することができ、その意味でも推定精度が向上する。

【００７１】図１１はこの発明の第２実施例を示す、図７に類似するフロー・チャートである。

【００７２】第１実施例と相違する点に焦点をおいて説明すると、Ｓ２００では図２フロー・チャートのＳ２６で算出された正味還流率をリングバッファに格納する。そしてＳ２０２で無駄時間τを検索し、Ｓ２０４で該当する正味還流率（これを「真の還流率」と称する）を読み出し、それから燃料噴射補正係数ＫＥＧＲＮを算出し、Ｓ２０６で燃料噴射量を補正する。

【００７３】このように、第２実施例は、検出された機関回転数および機関負荷、例えば吸気圧力と排気還流弁の作動状態とから前記排気還流弁を通過して燃焼室に流入する排気ガスの正味還流率を演算周期ごとに算出して記憶しておくと共に、排気ガスが排気還流弁を通過して燃焼室に流入するまでの無駄時間を求め、無駄時間に相当する演算周期の算出値を選択し、それを現在の演算周期で真に燃焼室に流入する排気還流率とみなすようにしたので、複雑な計算や不確定な演算要素を極力低減することができ、簡易な構成でありながら、燃焼室に流入する排気ガスの還流率を精度良く求めることができる。

【００７４】図１２は、この発明の第３実施例を示す、図７に類似するフロー・チャートである。

【００７５】第１実施例と相違する点に焦点をおいて説明すると、Ｓ３００ないしＳ３０２を経てＳ３０４に進み、所定の無駄時間（例えばτ＝１２）からリングバッファを検索して今回使用する燃料噴射補正係数ＫＥＧＲＮを検索する。即ち、無駄時間が固定した値である点を除けば、残余の構成および効果は第１実施例と相違しない。ここで、無駄時間は排気還流弁と燃焼室までの距離などにより、機関ごとに異なる値となるが、予め実験を通じて求めておくものとする。

【００７６】尚、第３実施例においても第２実施例と同様に、燃料噴射補正係数ＫＥＧＲＮの代わりに、正味還流率をリングバッファに格納しておいても良いことは言うまでもない。

【００７７】図１３はこの発明の第４実施例を示すフロー・チャートで、基本点火時期θＭＡＰの算出作業を示すフロー・チャートである。

【００７８】以下、説明すると、先ずＳ４００で現在の機関回転数ＮＥと吸気圧力ＰＢＡとより排気ガス非還流時用のθＭＡＰマップを検索して排気ガス非還流時の基本点火時期（以下「θＭＡＰＯ」と言う）を求め、次いでＳ４０２に進んで同じパラメータより排気ガス還流時用のθＭＡＰマップを検索して排気ガス還流時の基本点火時期（以下「θＭＡＰＴ」と言う）を求める。図１４に上記したθＭＡＰマップの特性を示す。

【００７９】次いでＳ４０４に進み、図示の式から基本点火時期θＭＡＰを算出する。図示の式によれば、排気ガス非還流時には燃料噴射補正係数ＫＥＧＲＮ＝１となるので、基本点火時期θＭＡＰは非還流時の基本点火時期θＭＡＰＯとなる。他方、燃料噴射補正係数ＫＥＧＲＮと定常時の燃料噴射補正係数ＫＥＧＲＭＡＰが一致する状態では、基本点火時期θＭＡＰは還流時の基本点火時期θＭＡＰＴとなる。また、燃料噴射補正係数ＫＥＧＲＮが定常時の燃料噴射補正係数ＫＥＧＲＭＡＰと一致しない状態では、基本点火時期θＭＡＰは、両者の比に応じて非還流時の基本点火時期θＭＡＰＯと還流時の基本点火時期θＭＡＰＴとの間を直線補間した値となる（このとき、実際の基本点火時期θＭＡＰが破線で示すような挙動を示しても、直線との差は微小なので、支障ない）。

【００８０】ここで、燃料噴射補正係数ＫＥＧＲＮは、図７に示した第１実施例、図１１に示した第２実施例、ないしは図１２に示した第３実施例で述べた無駄時間を考慮して求めた値を用いる。特に、図１１に示した第２実施例によるときは、（１－ＫＥＧＲＮ）の代わりに正味還流率を検索自在にバッファリングしておいても良い。

【００８１】更に、定常時の燃料噴射補正係数ＫＥＧＲＭＡＰは、図７に示した第１実施例、図１１に示した第２実施例、ないしは図１２に示した第３実施例で燃料噴射補正係数ＫＥＧＲＮや正味還流率をバッファリングするものに対応させて同時にバッファリングさせれば良い。更に、図７に示した第１実施例や図１２に示した第３実施例によるときは、予め（１－ＫＥＧＲＮ）／（１－ＫＥＧＲＭＡＰ）の値を求めて燃料噴射補正係数ＫＥＧＲＮと同様にバッファリングしても良いことは明らかである。

【0082】また、定常時の燃料噴射補正係数KEGRMAPは、より簡易に第1実施例の図2フロー・チャートで求めた現在値を利用しても良いが、その場合に（1－KEGRN）／（1－KEGRMAP）の値が1．0を超えるときは1．0に制限して算出値θMAPの点火時期が還流時の基本点火時期θMAPTを進角方向に超えないようにする必要がある。

【0083】第4実施例においては上記の如く、排気還流弁および還流ガスの流入遅れに応じて算出された燃料噴射補正係数KEGRNを用いて基本点火時期を決定するようにしたので、排気還流動作が行われるときも、点火時期を所望の値に正確に制御することができる。この基本点火時期は水温、吸気温などによる補正を行ってから出力される。尚、上記において燃料噴射補正係数KEGRNなどを用いて基本点火時期を直接決定したが、別途決定した基本点火時期を燃料噴射補正係数KEGRNなどを用いて補正しても良い。

【0084】尚、上記において、排気還流率ないしは燃料噴射補正係数を記憶しておき、無駄時間に応じて選択するようにしたが、排気還流率ないしは燃料噴射補正係数を算出するのに必要な機関回転数などのパラメータを記憶しておき、無駄時間に応じて選択し、選択した値に基づいて排気還流率ないしは燃料噴射補正係数を始めて算出するようにしても良い。

【0085】更に、上記において、図2のS10，S20，S22などで大気圧を用いたが、それに代えて排気圧力を用いても良い。

【0086】更に、上記において、値LCMD，KEGRMAP，QCMD，QACTをマップ値として設定しておいたが、その都度演算で求めても良い。

【0087】更に、上記において、排気還流弁として負圧式のものを用いたが、電気式であっても良い。

【0088】更に、機関負荷を示すパラメータとして吸気圧力を用いたが、吸入空気量、スロットル開度などを用いても良い。

【0089】

【発明の効果】請求項1項にあっては、複雑な計算や不確定な演算要素を極力低減することができ、簡易な構成でありながら、燃焼室に流入する排気ガスの還流率を精度良く求めることができる。

【0090】請求項2項にあっては、排気還流弁の流量特性から排気還流ガスの挙動を把握するようにしたので、複雑な計算や不確定な演算要素を極力減らすことができ、簡易な構成でありながら、実際に燃焼室に吸入される正味の排気還流率を精度良く推定することができる。

【0091】請求項3項にあっては、前記無駄時間が前記内燃機関の運転状態に応じて求められる如く構成したので、燃焼室に流入する排気ガスの還流率を一層的確に求めることができる。

【0092】請求項4項にあっては、複雑な計算や不確定な演算要素を極力減らすことができ、簡易な構成でありながら、実際に燃焼室に吸入される正味の排気還流率を精度良く推定することができ、それに基づいて燃料噴射量を適正に補正することができる。

【0093】請求項5項にあっては、複雑な計算や不確定な演算要素を極力減らすことができ、簡易な構成でありながら、実際に燃焼室に吸入される正味の排気還流率を精度良く推定することができ、それに基づいて点火時期を適正に補正することができる。

【0094】請求項6項にあっては、燃焼室に流入する排気ガスの還流率ないしは燃料噴射補正係数をより簡易に求めることができる。

【図面の簡単な説明】

【図1】この発明に係る内燃機関の排気還流率推定装置を全体的に示すブロック図である。

【図2】図1の排気還流率推定装置の動作を示すフロー・チャートである。

【図3】この発明に係る排気還流率推定の基本アルゴリズムを示す説明図で、図2フロー・チャートの演算に使用される排気還流率のリフト量に対するガス量の特性を示す説明図である。

【図4】排気還流弁のリフト指令値に対する実リフトおよび還流ガスの遅れを示す説明図である。

【図5】図2フロー・チャートの演算に使用される定常時の排気還流率補正係数（基本排気還流率補正係数）のマップ特性を示す説明図である。

【図6】図2フロー・チャートの演算に使用されるリフト指令値のマップ特性を示す説明図である。

【図7】図2フロー・チャートの燃料噴射補正係数の算出作業を示すサブルーチン・フロー・チャートである。

【図8】図7フロー・チャートの作業で使用されるリングバッファの構成を示す説明図である。

【図9】図7フロー・チャートの作業で使用される無駄時間τのマップ特性を示す説明図である。

【図10】図7フロー・チャートの作業を説明するタイミング・チャートである。

【図11】この発明の第2実施例を示す、図7に類似するフロー・チャートである。

【図12】この発明の第3実施例を示す、図7に類似するフロー・チャートである。

【図13】この発明の第4実施例を示すフロー・チャートである。

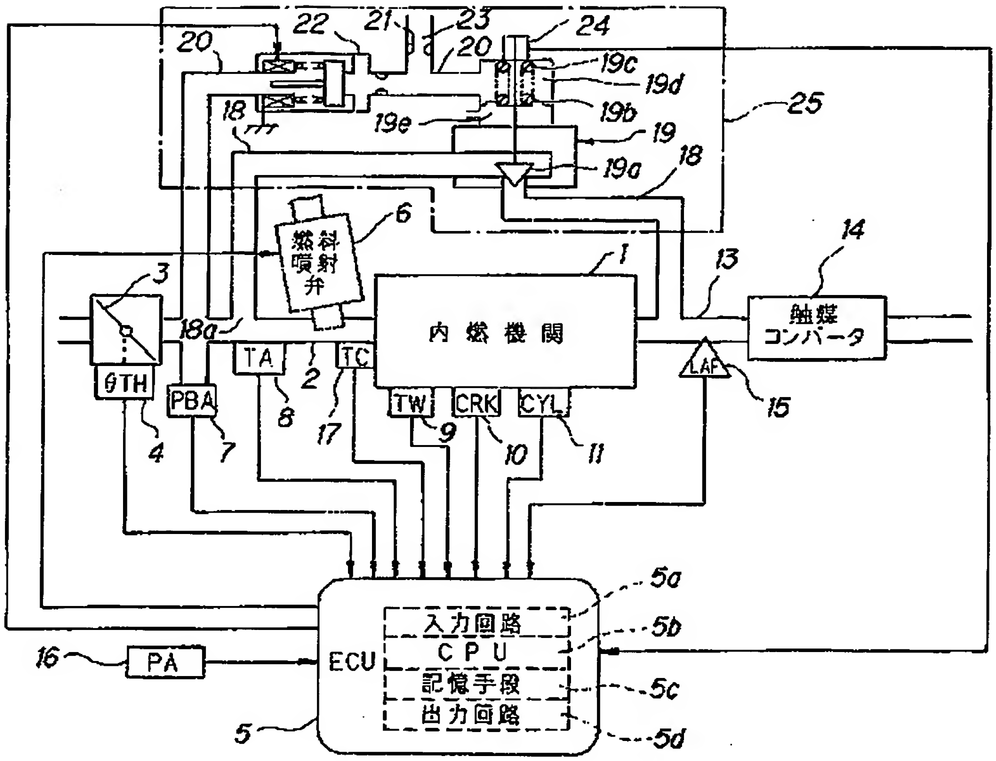
【図14】図14フロー・チャートの作業で使用されるθMAPマップの特性を示す説明図である。

【符号の説明】

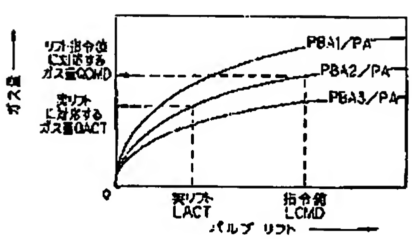
1 内燃機関本体
2 吸気管
5 電子制御ユニット（ECU）
7 絶対圧センサ

１０　クランク角センサ
１６　大気圧センサ
１８　排気還流通路
＊１９　排気還流弁
２５　排気還流機構
＊

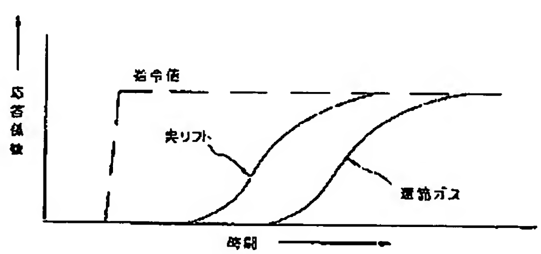
【図１】



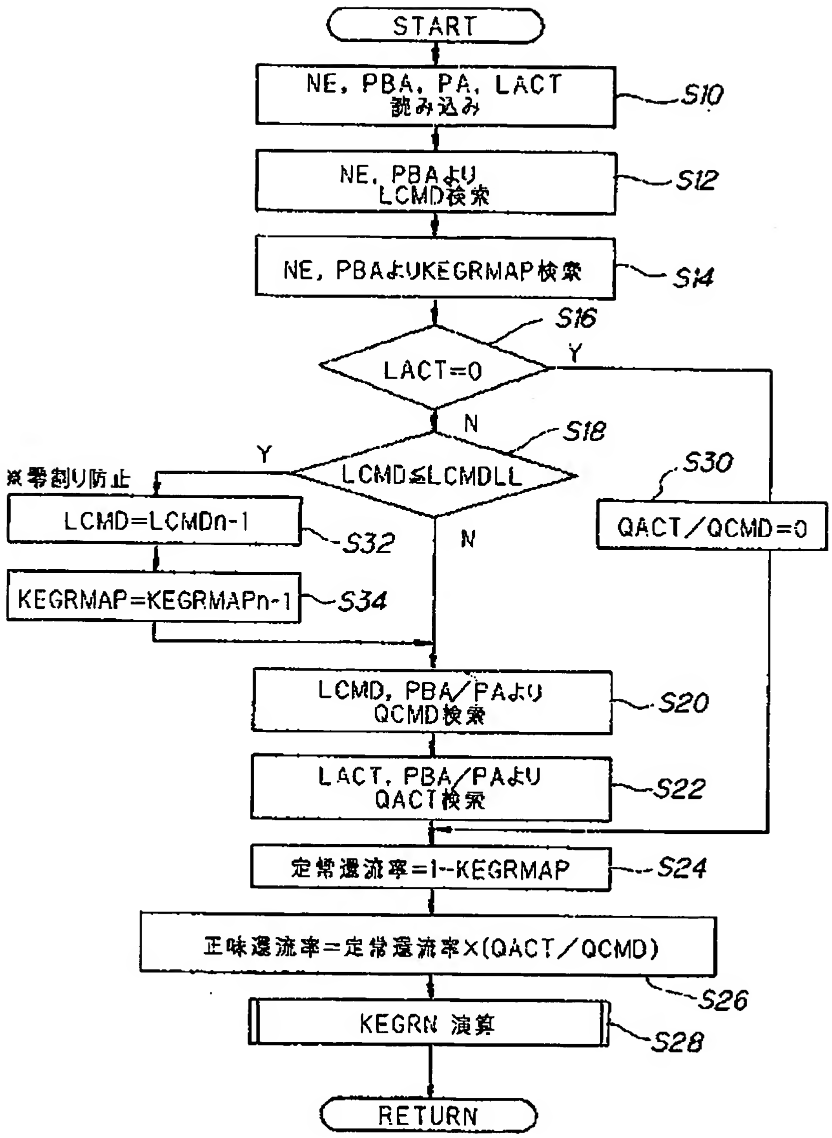
【図３】



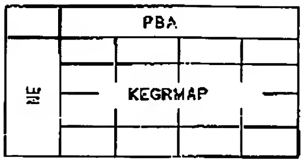
【図４】



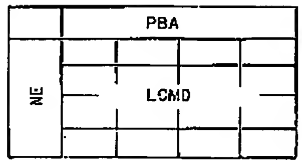
【図2】


START
NE, PBA, PA, LACT
読み込み
S10
NE, PBAより
LCMD検索
S12
NE, PBAよりKEGRMAP検索
S14
S16
LACT=0
Y
N
S18
Y
※零割り防止
LCMD≦LCMDLL
S30
LCMD=LCMDn-1
S32
N
QACT／QCMD=0
KEGRMAP=KEGRMAPn-1
S34
LCMD, PBA／PAより
QCMD検索
S20
LACT, PBA／PAより
QACT検索
S22
定常還流率=1-KEGRMAP
S24
正味還流率=定常還流率×(QACT／QCMD)
S26
KEGRN 演算
S28
RETURN

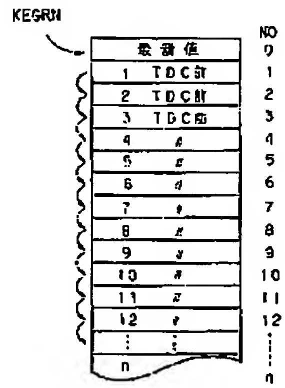
【図5】



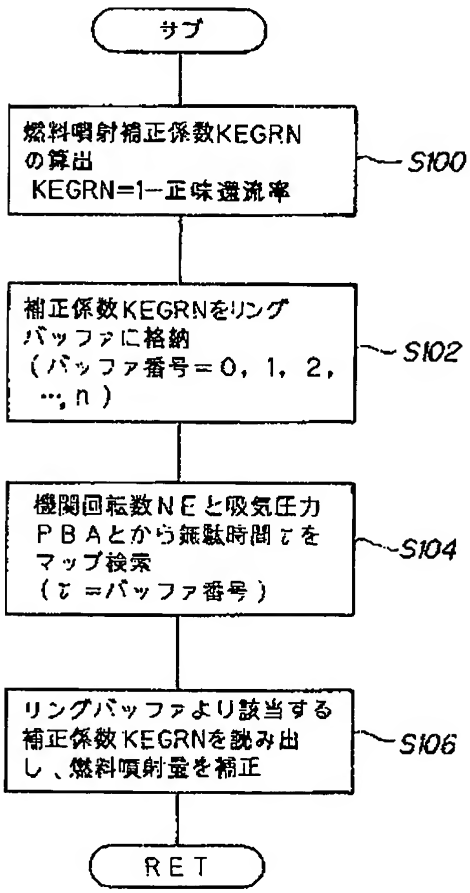
【図6】



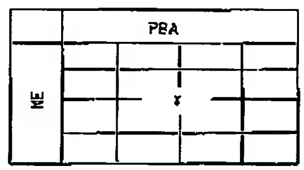
【図8】



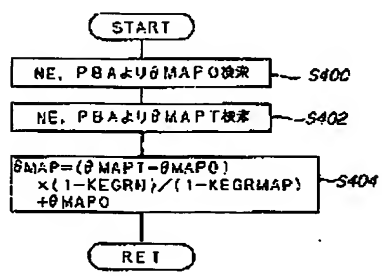
【図7】



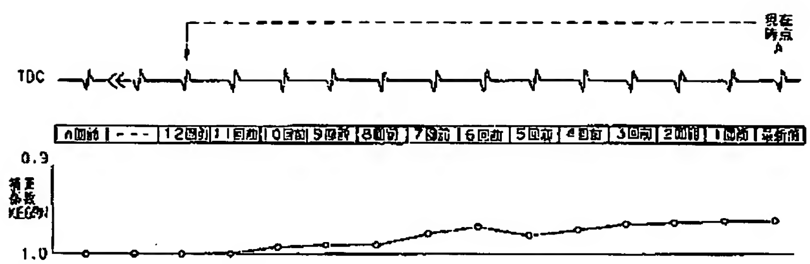
【図9】



【図13】

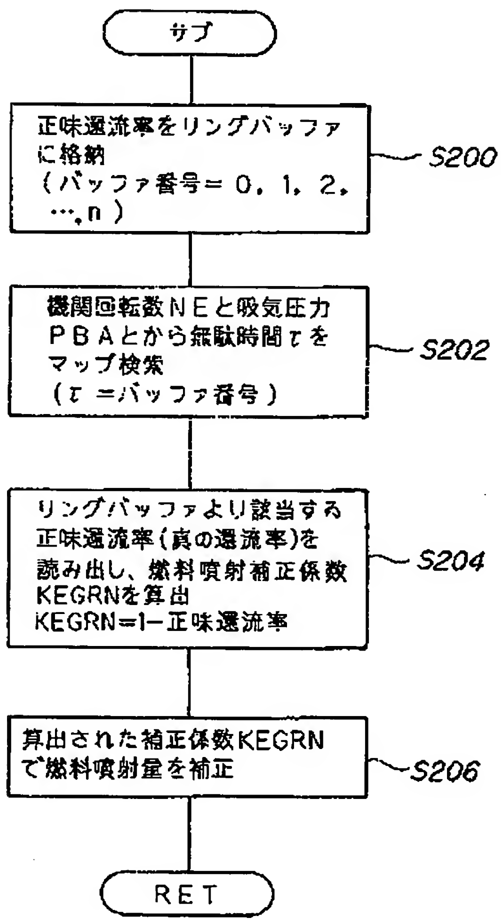


【図10】

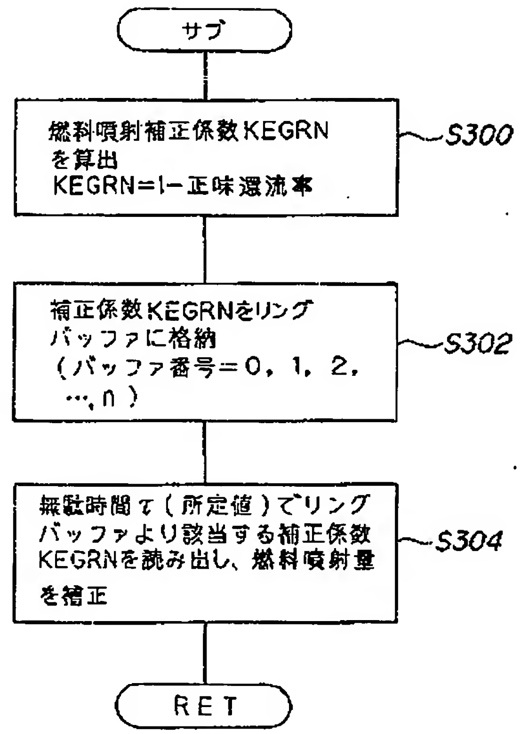

現在時点A
TDC
n回前

12回前
11回前
10回前
9回前
8回前
7回前
6回前
5回前
4回前
3回前
2回前
1回前
最新値
0.9
補正係数KEGRN
1.0

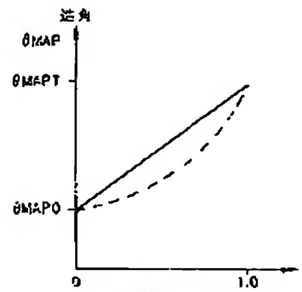
【図11】


サブ
正味還流率をリングバッファに格納（バッファ番号＝0，1，2，…，n）
S200
機関回転数ＮＥと吸気圧力ＰＢＡとから無駄時間τをマップ検索（τ＝バッファ番号）
S202
リングバッファより該当する正味還流率（真の還流率）を読み出し、燃料噴射補正係数KEGRNを算出
KEGRN＝1－正味還流率
S204
算出された補正係数KEGRNで燃料噴射量を補正
S206
RET

【図12】


サブ
燃料噴射補正係数KEGRNを算出
KEGRN＝1－正味還流率
S300
補正係数KEGRNをリングバッファに格納（バッファ番号＝0，1，2，…，n）
S302
無駄時間τ（所定値）でリングバッファより該当する補正係数KEGRNを読み出し、燃料噴射量を補正
S304
RET

【図14】



フロントページの続き

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CLAIMS

[Claim(s)]
[Claim 1] In the internal combustion engine which comes to have the exhaust gas reflux path which connects an internal combustion engine's flueway and inhalation-of-air path, and flows back to said inhalation-of-air path in a part of exhaust gas [at least], and the exhaust air reflux valve which open and close this exhaust gas reflux path a. An operational status detection means to detect the operational status of said internal combustion engine which contains an engine rotational frequency and an engine load at least for every predetermined detection period, b. An exhaust air reflux valve-action condition detection means to detect the operating state of said exhaust air reflux valve for said every predetermined detection period, c. A dead time until said exhaust gas passes an exhaust air reflux valve and flows into a combustion chamber is found. The detection period front which is equivalent to this dead time from the detected operational status and the operating state of an exhaust air reflux valve, A rate calculation means of exhaust air reflux to compute the rate of reflux of the exhaust gas which passes said exhaust air reflux valve and flows into a combustion chamber, And rate presumption equipment of exhaust air reflux of the internal combustion engine characterized by having a rate decision means of exhaust air reflux to consider that the computed rate of exhaust air reflux this [d.] is the rate of reflux of the exhaust gas which flows into said internal combustion engine's combustion chamber.
[Claim 2] said rate calculation means of exhaust air reflux -- e. -- a rate decision means of basic exhaust air reflux to determine the rate of basic exhaust air reflux from an engine rotational frequency and an engine load at least -- f. The 1st presumed means which presumes the amount of exhaust gas which passes said exhaust air reflux valve according to the opening area detection value of said exhaust air reflux valve based on the flow characteristics of said exhaust air reflux valve, g. The 2nd presumed means which presumes the amount of exhaust gas which passes said exhaust air reflux valve according to the opening area command value of said exhaust air reflux valve based on the flow characteristics of said exhaust air reflux valve, And it asks for the ratio of the amount of exhaust gas presumed with the h. above 1st and the 2nd presumed means. a calculation means to compute the rate of reflux of the exhaust gas which amends said rate of basic exhaust air reflux according to this ****** ratio, and flows into said internal combustion engine's combustion chamber -- since -- the rate presumption equipment of exhaust air reflux of the internal combustion engine given in claim 1 term characterized by becoming.
[Claim 3] Claim 1 term characterized by finding said dead time according to said internal combustion engine's operational status, or rate presumption equipment of exhaust air reflux of an internal combustion engine given in dyadic.
[Claim 4] Said rate decision means of exhaust air reflux is rate presumption equipment of exhaust air reflux of an internal combustion engine given in either claim 1 term characterized by having a correction factor calculation means to ask for the correction factor which amends the fuel oil consumption which should be supplied to said internal combustion engine's combustion chamber according to said rate of exhaust air reflux thru/or the 3rd term.
[Claim 5] Said rate decision means of exhaust air reflux is rate presumption equipment of exhaust air reflux of an internal combustion engine given in either claim 1 term characterized by having a correction factor calculation means to ask for the correction factor which amends said internal combustion engine's ignition timing according to said rate of exhaust air reflux thru/or the 4th term.

[Claim 6] Said rate decision means of exhaust air reflux is equipped with the storage means of the rate of exhaust air reflux and correction factor which synchronized with said predetermined detection period and which are beforehand computed for every operation period which carries out the sequential storage of either at least. Rate presumption equipment of exhaust air reflux of an internal combustion engine given in either claim 1 term characterized by the thing of said rate of exhaust air reflux memorized by this storage means according to said dead time, and said correction factor for which either is chosen at least thru/or the 5th term.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] More specifically, this invention relates to the rate presumption equipment of exhaust air reflux of the internal combustion engine which presumed the rate of reflux of the exhaust gas which flows into an engine combustion chamber with a simply and sufficient precision about an internal combustion engine's rate presumption equipment of exhaust air reflux. In addition, "the rate of exhaust air reflux" means the volume ratio or weight ratio of exhaust gas / inhalation air here.
[0002]
[Description of the Prior Art] While preparing the exhaust air reflux path which connects an internal combustion engine's flueway and inhalation-of-air path and making a part of exhaust gas flow back to said inhalation-of-air path An exhaust air reflux valve is prepared there and the amount of reflux is controlled, and in the exhaust air reflux control which aims at reduction of NOx, and improvement in fuel consumption, in order to perform exhaust air reflux control with a sufficient precision, it is necessary to presume correctly the rate of reflux (henceforth "the rate of net reflux") thru/or the amount of exhaust air reflux of exhaust gas which actually flows into a combustion chamber. Moreover, since the amount of exhaust air reflux serves as disturbance when controlling an internal combustion engine's air-fuel ratio or fuel oil consumption, it needs to presume the rate of exhaust air reflux thru/or the amount of exhaust air reflux with a sufficient precision also in the semantics.
[0003] So, the technique of presuming a partial pressure, total pressure, etc. of the reflux gas of an inhalation-of-air path and air from the inflow to the inhalation-of-air path of reflux gas, and computing the inflow air content to a gas column is shown in JP,4-311643,A. However, by the technique, in order to ask for the partial pressure of reflux gas, it is necessary to ask for not only the inflow to the inhalation-of-air path of reflux gas but an intake-air temperature, or the chamber volume correctly, and complicated count is needed. First of all, it is very difficult for there to be also dynamic delay of reflux gas and to calculate correctly the inflow to the inhalation-of-air path of reflux gas.
[0004]
[Problem(s) to be Solved by the Invention] Therefore, it is in the purpose of this invention canceling the fault which the conventional technique described above, and complicated count and an indefinite operational element are reduced as much as possible, and though it is a simple configuration, it is in offering the rate presumption equipment of exhaust air reflux of the internal combustion engine which asked for the rate of reflux of the exhaust gas which flows into a combustion chamber with a sufficient precision.
[0005] Furthermore, the exhaust gas which flows into a combustion chamber serves as disturbance, when controlling fuel oil consumption so that an air-fuel ratio serves as desired value.
[0006] Therefore, the 2nd purpose of this invention reduces complicated count and an indefinite operational element as much as possible, and though it is a simple configuration, it is to offer the rate presumption equipment of exhaust air reflux of the internal combustion engine which amended fuel oil consumption correctly in quest of the rate of reflux of the exhaust gas which flows into a combustion chamber with a sufficient precision.
[0007] Furthermore, since the exhaust gas which flows into a combustion chamber reduces the

ignitionability of gaseous mixture, it serves as disturbance also in ignition timing control.
[0008] Therefore, the 3rd purpose of this invention reduces complicated count and an indefinite operational element as much as possible, and though it is a simple configuration, it is to offer the rate presumption equipment of exhaust air reflux of the internal combustion engine which amended ignition timing correctly in quest of the rate of reflux of the exhaust gas which flows into a combustion chamber with a sufficient precision.
[0009]
[Means for Solving the Problem] The exhaust gas reflux path which this invention is claim 1 term, and connects an internal combustion engine's flueway and inhalation-of-air path, and flows back to said inhalation-of-air path in a part of exhaust gas [at least] in order to attain the 1st purpose, In the internal combustion engine which comes to have the exhaust air reflux valve which opens and closes this exhaust gas reflux path An operational status detection means to detect the operational status of said internal combustion engine which contains an engine rotational frequency and an engine load at least for every predetermined detection period, An exhaust air reflux valve-action condition detection means to detect the operating state of said exhaust air reflux valve for said every predetermined detection period, A dead time until said exhaust gas passes an exhaust air reflux valve and flows into a combustion chamber is found. The detection period front which is equivalent to this dead time from the detected operational status and the operating state of an exhaust air reflux valve, It constituted so that it might have a rate calculation means of exhaust air reflux to compute the rate of reflux of the exhaust gas which passes said exhaust air reflux valve and flows into a combustion chamber, and a rate decision means of exhaust air reflux to consider that the computed this rate of exhaust air reflux is the rate of reflux of the exhaust gas which flows into said internal combustion engine's combustion chamber.
[0010] In claim 2 term more specifically said rate calculation means of exhaust air reflux A rate decision means of basic exhaust air reflux to determine the rate of basic exhaust air reflux from an engine rotational frequency and an engine load at least, The 1st presumed means which presumes the amount of exhaust gas which passes said exhaust air reflux valve according to the opening area detection value of said exhaust air reflux valve based on the flow characteristics of said exhaust air reflux valve, The 2nd presumed means which presumes the amount of exhaust gas which passes said exhaust air reflux valve according to the opening area command value of said exhaust air reflux valve based on the flow characteristics of said exhaust air reflux valve, and a calculation means to compute the rate of reflux of the exhaust gas which asks for the ratio of the amount of exhaust gas presumed with the said 1st and 2nd presumed means, amends said rate of basic exhaust air reflux according to this ****** ratio, and flows into said internal combustion engine's combustion chamber -- since -- it constituted so that it might become.
[0011] In claim 3 term, more specifically, it constituted so that said dead time might be found according to said internal combustion engine's operational status.
[0012] In order to attain the 2nd purpose, in claim 4 term, said rate decision means of exhaust air reflux was constituted so that it might have a correction factor calculation means to ask for the correction factor which amends the fuel oil consumption which should be supplied to said internal combustion engine's combustion chamber according to said rate of exhaust air reflux.
[0013] In order to attain the 3rd purpose, in claim 5 term, said rate decision means of exhaust air reflux was constituted so that it might have a correction factor calculation means to ask for the correction factor which amends said internal combustion engine's ignition timing according to said rate of exhaust air reflux.
[0014] In order to attain the 1st thru/or the 3rd purpose, it sets in claim 6 term. More specifically Said rate decision means of exhaust air reflux is equipped with the storage means of the rate of exhaust air reflux and correction factor which synchronized with said predetermined detection period and which are beforehand computed for every operation period which carries out the sequential storage of either at least. Even if there were few said rates of exhaust air reflux memorized by this storage means according to said dead time and said correction factors, it constituted so that either might be chosen.
[0015]
[Function] A dead time if it is in claim 1 term, until exhaust gas passes an exhaust air reflux valve

and flows into a combustion chamber is found. The detection period from which is equivalent to this dead time from the detected operational status and the operating state of an exhaust air reflux valve, A rate calculation means of exhaust air reflux to compute the rate of reflux of the exhaust gas which passes said exhaust air reflux valve and flows into a combustion chamber, And since it constituted so that it might have a rate decision means of exhaust air reflux to consider that the computed this rate of exhaust air reflux is the rate of reflux of the exhaust gas which flows into said internal combustion engine's combustion chamber Complicated count and an indefinite operational element can be reduced as much as possible, and though it is a simple configuration, it can ask for the rate of reflux of the exhaust gas which flows into a combustion chamber with a sufficient precision. Here, a dead time may be made adjustable according to operational status, or is good also as a fixed value according to an engine's structure.

[0016] In claim 2 term said rate calculation means of exhaust air reflux Determine the rate of basic exhaust air reflux from an engine rotational frequency and an engine load, and it is based on the flow characteristics of said exhaust air reflux valve. The amount of exhaust gas which passes said exhaust air reflux valve according to the opening area detection value and command value of said exhaust air reflux valve is presumed, respectively. Since it constituted so that the rate of reflux of the exhaust gas which amends the rate of basic exhaust air reflux from those ratios, and flows into said internal combustion engine's combustion chamber might be computed Since the behavior of exhaust air reflux gas will be grasped from the flow characteristics of an exhaust air reflux valve if it puts in another way, complicated count and an indefinite operational element can be reduced as much as possible, and though it is a simple configuration, the rate of exhaust air reflux of the net actually inhaled in a combustion chamber can be presumed with a sufficient precision.

[0017] Since it constituted so that said dead time might be found according to said internal combustion engine's operational status if it was in claim 3 term, it can ask for the rate of reflux of the exhaust gas which flows into a combustion chamber much more exactly.

[0018] Since it constituted so that it might ask for the correction factor which amends fuel oil consumption according to said rate of exhaust air reflux if it was in claim 4 term, complicated count and an indefinite operational element can be reduced as much as possible, though it is a simple configuration, the rate of exhaust air reflux of the net actually inhaled in a combustion chamber can be presumed with a sufficient precision, and fuel oil consumption can be amended proper based on it.

[0019] Since it constituted so that it might ask for the correction factor which amends ignition timing according to said rate of exhaust air reflux if it was in claim 5 term, complicated count and an indefinite operational element can be reduced as much as possible, though it is a simple configuration, the rate of exhaust air reflux of the net actually inhaled in a combustion chamber can be presumed with a sufficient precision, and ignition timing can be amended proper based on it.

[0020] If it is in claim 6 term, it can ask for the rate of exhaust air reflux beforehand computed for every operation period, said rate of exhaust air reflux of a correction factor which carried out the sequential storage of either at least, and was memorized by this storage means according to said dead time and the rate of reflux of the exhaust gas of said correction factor which flows into a combustion chamber since it constituted so that either might be chosen at least, or a fuel-injection correction factor more simply. In addition, it chooses according to a dead time, and based on the selected value, the rate of exhaust air reflux or a fuel-injection correction factor is begun, and you may make it memorize the rate of exhaust air reflux, or the operational status detection value required for calculation of a correction factor, and ask.

[0021]

[Example] Hereafter, it is based on an accompanying drawing and the example of this invention is explained.

[0022] Drawing 1 is the whole block diagram showing the rate presumption equipment of exhaust air reflux of the internal combustion engine concerning this invention. An internal combustion engine is an internal combustion engine of a 4-cylinder, and a throttle valve 3 is formed in the middle of the inlet pipe (inhalation-of-air path) 2 of the engine body 1. The throttle location sensor (thetaTH shows) 4 which detects throttle location thetaTH is connected with a throttle valve 3, and an output is supplied to an electronic control unit (henceforth "ECU") 5.

[0023] ECU5 operates the input signal wave from the throttle location sensor 4 and the below-mentioned sensor group orthopedically, corrects a voltage level to predetermined level, and consists of storage means 5c which memorizes various operation programs, the result of an operation, etc. which are performed by input circuit 5a which has the function of changing an analog signal into a digital signal value, CPU5b, and CPU5b, 5d of output circuits etc., etc.
[0024] a fuel injection valve 6 -- between the engine body 1 and throttle valves 3 -- and it is prepared in the upstream of the suction port (not shown) of a combustion chamber (not shown) for every gas column. A fuel injection valve 6 is electrically connected to ECU5 while connecting with a fuel pump (not shown). On the other hand, while the absolute-pressure sensor (PBA shows) 7 which detects the pressure PBA of inhalation of air with absolute pressure is formed in the lower stream of a river of a throttle valve 3, the intake temperature sensor (TA shows) 8 which detects an intake-air temperature TA is formed in the lower stream of a river. The output of these sensors is also sent out to ECU5.
[0025] Moreover, while the coolant temperature sensor (TW shows) 9 which detects the engine cooling water temperature TW is formed in the engine body 1, the crank angle sensor (CRK shows) 10 which detects CRK whenever [including a TDC location / predetermined crank angle], and the gas column distinction sensor (CYL shows) 11 which detects CYL whenever [predetermined crank angle / of a specific gas column] are formed in a crankshaft or a cam shaft (not shown [both]). The output of these sensors is also sent out to ECU5, the crank angle sensor output CRK is counted through a counter (not shown), and the engine rotational frequency NE is detected.
[0026] Moreover, the catalytic converter 14 is arranged at the exhaust pipe (flueway) 13 of the engine body 1, and HC in exhaust gas, CO, an NOx component, etc. are purified. The upstream of a catalytic converter 14 is equipped with the broader-based air-fuel ratio sensor (LAF shows) 15 which detects the oxygen density in exhaust gas in the large range covering Lean since rich considering theoretical air fuel ratio as a core, and an output is supplied to ECU5.
[0027] Furthermore, while the atmospheric pressure sensor (PA shows) 16 which detects atmospheric pressure PA is formed near the engine body 1, the wall-temperature sensor (TC shows) 17 which detects the wall temperature TC is formed in the wall surface of the inlet pipe 2 near a suction port. The output of these sensors is also supplied to ECU5.
[0028] Next, the exhaust air reflux device 25 is explained.
[0029] The exhaust air reflux path 25 is equipped with the exhaust air reflux path 18 which connects an exhaust pipe 13 to an inlet pipe 2 (sign 18a shows the opening edge of an inhalation-of-air tubeside). In the middle of the exhaust air reflux path 18, the exhaust air reflux valve (EGR valve) 19 is formed. The exhaust air reflux valve 19 is a negative pressure corresponding movement type, and consists of valve element 19a arranged mainly so that a path 18 can be opened and closed, diaphragm 19b which operates with the negative pressure which is connected with valve element 19a and introduced through the below-mentioned solenoid valve 22, and spring 19c which energizes diaphragm 19b in the direction of clausilium.
[0030] The free passage way 20 is connected to negative pressure room 19d formed by diaphragm 19b, and it is constituted so that the negative pressure in an inlet pipe 2 may be introduced through the normally closed mold solenoid valve 22 formed in the middle of this free passage way 20. Atmospheric-air room 19e is open for free passage to atmospheric air. furthermore, the atmospheric-air free passage way 23 is connected to the free passage way 20 on the lower stream of a river of a solenoid valve 22, and it is this free passage way 23 -- on the way -- the orifice 21 boiled and prepared -- minding -- atmospheric pressure -- the free passage way 20 -- subsequently -- said negative pressure room -- it is constituted so that it may be introduced into 19d.
[0031] It connects with ECU5, and said solenoid valve 22 operates with the driving signal from ECU5, and controls lift actuation (valve-opening actuation) of valve element 19a of the exhaust air reflux valve 19, and its rate. The lift sensor 24 is formed in the exhaust air reflux valve 19, the travel (the amount of lifts) of valve element 19a is detected, and an output is sent out to ECU5. Moreover, ECU5 computes fuel oil consumption, and ignition timing is computed and it lights the gaseous mixture of an engine combustion chamber through the ignition means which is not illustrated while it controls the fuel oil consumption which should be supplied to an engine combustion chamber through the valve-opening time amount of said fuel injection valve 6.

[0032] Here, ECU5 presumes the rate of exhaust air reflux, and amends fuel oil consumption or ignition timing based on estimate so that it may state below.
[0033] Drawing 2 is a flow chart explaining presumed actuation of the rate of exhaust air reflux.
[0034] Before going into this description of drawing, the algorithm of the presumed actuation which relates to this invention below with reference to drawing 3 is explained.
[0035] If the capacity which passes an exhaust air reflux valve is seen as a valve simple substance, it will be determined by the opening area of a valve and the pressure ratio before and behind a valve, i.e., flow characteristics, (design item). That is, it is thought that it asks from the ratio of the opening area of lifts of a valve, i.e., the amount, and the vertical fluid pressure force of a valve.
[0036] as the system be show in drawing 3 , it be think by ask for the ratio of the amount of lifts of a valve , and the atmospheric pressure PA which act through said atmospheric air free passage way 23 and MAP PBA of an inlet pipe 2 that until presumption of reflux capacity be to some extent possible (although flow characteristics change with exhaust gas pressure or exhaust-gas temperatures a little in fact , it be think that change of the property be absorbable to remarkable extent by use a capacity rate like the after-mentioned) .
[0037] Then, paying attention to this point, it asked for the rate of reflux based on flow characteristics first. In addition, although opening area is calculated from the amount of lifts, this is because the amount of lifts used the valve of the structure corresponding to opening area. Therefore, when using the thing of another structures, such as a linear solenoid, it will ask for opening area from another parameter.
[0038] By the way, although there are a rate of reflux at the time of a stationary and a rate of reflux of a transient as rate of reflux, it is the value of the condition that the rate of reflux at the time of a stationary has a lift command value equal to a real lift, and as it is indicated in drawing 4 as the rate of reflux of a transient, a lift command value is a value of the condition which is not equal to a real lift. And with the algorithm concerning this invention, I thought that the difference in a transient was produced when the rate of reflux shifted from the rate of reflux at the time of a stationary by the capacity rate corresponding to it as shown in drawing 3 .
[0039] Specifically by the time of a stationary, it is a lift command value = real lift and capacity rate =1 [0040] of reflux, i.e., the rate at the time of a rate of reflux = stationary. In a transient, it becomes a lift command value != real lift and capacity rate !=1, i.e., the rate of reflux (map search values) x capacity rate at the time of a rate of reflux = stationary.
[0041] Thus, I thought that the rate of net reflux which flows into a combustion chamber was called for by multiplying the rate of reflux at the time of a stationary by the rate of the amount of ring main. If a formula shows, it will become as the following.
Rate of net reflux =(rate of reflux at time of stationary) x(capacity QACT which can be found from pressure ratio before and behind real lift and valve)/(capacity QCMD which can be found from a lift command value and the pressure ratio before and behind a valve)
[0042] Here, the rate of reflux at the time of a stationary asks for the rate correction factor of reflux, and asks for it by subtracting it from 1. That is, when the rate correction factor of reflux at the time of a stationary is called KEGRMAP, it is rate [at the time of a stationary] of reflux = (1-KEGRMAP).
It comes out and asks.
[0043] In addition, on these specifications, the rate of reflux at the time of a stationary thru/or the rate correction factor of reflux at the time of a stationary are also called the rate of basic exhaust air reflux thru/or the rate correction factor of basic exhaust air reflux. Moreover, the rate correction factor KEGRMAP of reflux at the time of a stationary was set up as a map, as it asked in an experiment beforehand from the engine rotational frequency NE and MAP PBA and was shown in drawing 5 , searches it and asked for it.
[0044] By the way, in exhaust air reflux control, although carried out by determining the lift command value of an exhaust air reflux valve from an engine rotational frequency, an engine load, etc., as shown in drawing 4 , a real lift (lift detection value) has delay to a command value. Furthermore, there is delay also in reflux gas flowing into a combustion chamber according to the valve-opening actuation.
[0045] Then, the inside of the amount of the reflux gas by which these people passed the exhaust air

reflux valve in JP,5-118239[illegible]eviously, The rate that the amount whic[illegible]wed into the control cycle in the combustion cha[illegible]r occupies is made into the rate of direct. [illegible]e model which describes the behavior of reflux gas which passes before it, is piling up in the space part to a combustion chamber, has away the rate that the amount which flowed into the combustion chamber occupies in the control cycle, and is made into a rate was stood, and the technique of presuming the rate of net reflux based on it was proposed.
[0046] However, it became clear that it tends to express the behavior of reflux gas that the reflux gas which passed the exhaust air reflux valve as a result of considering the behavior of reflux gas further considers that flows into a combustion chamber at once after a certain dead time passes. Then, while computing the rate of net reflux described above for every predetermined period and storing in the storage means, it was made to regard it as the rate of reflux of the exhaust gas which flowed into the combustion chamber truly with the calculation value of the period of the past equivalent to a dead time.
[0047] Hereafter, actuation of the equipment concerning an example is explained according to the drawing 2 flow chart. In addition, the program shown in this flow chart is started in each TDC location.
[0048] The engine rotational frequency NE, MAP PBA, atmospheric pressure PA, the real lift LACT (output of the lift sensor 24), etc. are first read by S10, it progresses to S12, and the lift command value LCMD is searched from the engine rotational frequency NE and MAP PBA. The lift command value LCMD searches and asks for **** shown in drawing 6 , and the map which defined and set up the property beforehand here.
[0049] Then, the map shown in drawing 5 which progressed to S14 and was described above from the engine rotational frequency NE and MAP PBA is searched, and the rate correction factor KEGRMAP of basic exhaust air reflux is searched.
[0050] Subsequently, the lift command value LCMD which checked that checked that the real lift LACT which progressed to S16 and was detected is not zero, namely, the exhaust air reflux valve 19 was opening, progressed to S18, and was searched is compared with the predetermined lower limit LCMDLL (minute value).
[0051] the time of it being judged that search values are not below lower limits in S18 -- S20 -- progressing -- there -- the ratio of MAP PBA and atmospheric pressure PA -- PBA/PA is calculated, from it and the searched lift command value LCMD, what map-ized the property shown in drawing 3 (not shown) is searched, and capacity QCMD is calculated. This is "capacity which can be found from a lift command value and the pressure ratio before and behind a valve" told to a previous formula.
[0052] then, the same ratio as the real lift LACT which progressed to S22 and was detected -- what map-ized the property similarly shown in drawing 3 from PBA/PA (not shown) is searched, and capacity QACT is calculated. This is equivalent to "the capacity which can be found from the pressure ratio before and behind a real lift and a valve" said with a previous formula.
[0053] Then, let the value which subtracted and obtained from 1 the rate correction factor KEGRMAP of basic exhaust air reflux which progressed to S24 and was searched be a rate of stationary reflux (the rate of basic exhaust air reflux thru/or rate of reflux at the time of a stationary). Here, like the above, the rate of reflux at the time of exhaust air reflux actuation being stable, i.e., exhaust air reflux actuation, is started, or the rate of reflux at the time of a stationary means the rate of reflux when being in the transitional conditions at the time of being stopped etc.
[0054] S26 [then,] -- progressing -- like illustration -- the rate of stationary reflux -- the ratio of values QACT and QCMD -- it multiplies by QACT/QCMD and asks for the rate of net reflux.
[0055] Then, it progresses to S28 and the fuel-injection correction factor KEGRN is calculated. Drawing 7 is a subroutine flow chart which shows the activity.
[0056] If it explains according to this drawing, in S100, the rate of net reflux (that for which it asked by S26 of drawing 2) will be subtracted from 1, and let the value be the fuel-injection correction factor KEGRN.
[0057] Then, the fuel-injection correction factor KEGRN which progressed to S102 and was computed is stored in a ring buffer (storage). Drawing 8 is the explanatory view showing the configuration of the ring buffer, and is prepared in storage means 5c of above mentioned ECU5.

[0058] A ring buffer has the addresses like illustration, the number fro[illegible]o n is attached and each address is specified. And whenever the fuel-injection correction factor KEGRN is computed by the drawing 2 (and drawing 7) flow chart being started by TDC, in drawing, sequential storing (updating) is carried out from the upper part.
[0059] Then, a map is searched from the engine rotational frequency NE which progressed to S104 and was detected, and the engine load PBA, for example, a MAP, and a dead time tau is searched. Drawing 9 is the explanatory view showing the property.
[0060] That is, although the above mentioned dead time shows a time delay until the reflux gas which passed the exhaust air reflux valve flows into a combustion chamber, it changes according to an engine rotational frequency and an engine load, for example, a MAP etc. Here, a dead time tau is described above and is more specifically shown by the buffer number.
[0061] Then, based on the dead time tau (specifically buffer number) which progressed to S106 and was searched, the calculation value (fuel-injection correction factor KEGRN) stored in the corresponding address is read. That is, as shown in drawing 10 , when the present time is A, the calculation value of 12 times ago is chosen, and let it be this fuel-injection correction factor KEGRN.

[0062] If this is seen from actuation of an exhaust air reflux valve, the fuel-injection correction factor KEGRN of 12 times ago is 1.0, and that means that the exhaust air reflux valve was closed. after that -- the fuel-injection correction factor KEGRN -- for example, 0. -- it judges that reflux gas is not yet flowing into a combustion chamber at the current time in the case of the example of illustration although the exhaust air reflux valve could open when becoming gradually as small as 99, 0.98, etc. and putting in another way, and it has resulted in A at the current time, therefore is made not to perform reduction amendment in fuel injection.
[0063] Fuel oil consumption is amended based on the fuel-injection correction factor KEGRN determined as coincidence. Although amendment of this fuel oil consumption is performed by multiplying the basic fuel oil consumption Tim calculated from the engine rotational frequency and the engine load by the correction factor KEGRN, and calculating the output fuel oil consumption Tout, since this very thing is well-known, it stops to explanation of this level.
[0064] If it returns to the drawing 2 flow chart, when the real lift LACT is judged to be zero by S16, in addition, exhaust air reflux is not performed, but since the fuel-injection correction factor KEGRN is determined from the value after a dead time tau passes, it computes the rate of net reflux, and the fuel-injection correction factor KEGRN by progressing after S24. In this case, by S26, the rate of net reflux is determined as 0, and the fuel-injection correction factor KEGRN is determined as 1.0 S100 of R> drawing 7 7 flow chart.
[0065] Moreover, when the lift command value LCMD is judged to be below the lower limit LCMDLL by S18, it progresses to S32, and as for the lift command value LCMD, last value LCMDn-1 is held as it is (giving n to a value by this flow chart this time omitted for simplification).
[0066] Since delay is in the dynamic characteristics of the exhaust air reflux valve 19 even if the lift command value LCMD becomes zero when this shifts to the field which is not performed from the field which performs exhaust air reflux, Since the real lift LACT did not become zero immediately, when the lift command value LCMD was below the lower limit (threshold) LCMDLL, it held the lift command value LCMD to last value LCMDn-1 (at the time [Last time] of a control cycle value at the time of n-1). Last time [this], a value hold is performed until it is checked that the real lift LACT has become zero by S16.
[0067] Moreover, when the lift command value LCMD is below the lower limit LCMDLL, the lift command value LCMD may be zero, and in that case, the QCMD search values of S20 also serve as zero, and a zero rate arises by the operation of S26, and it becomes operation impossible. However, there is no possibility that calculating may become impossible, by holding a value last time like the above. In addition, zero are sufficient although the lower limit LCMDLL considered as the minute value.
[0068] Then, it progresses to S34 and they are the map search values (it refers to S14) of the rate correction factor KEGRMAP of basic exhaust air reflux Last search-values KEGRMAPn-1 It replaces. This is because it is set as 1, so there is a possibility that the rate of stationary reflux may be set to 0 in the operation of S24, in the property which the rate correction factor KEGRMAP of basic

exhaust air reflux from whic[illegible] lift command value LCMD searched w[illegible]12 is searched with S14 in the operational status [illegible]ged to be below a lower limit plans in thi[illegible]ample.

[0069] This example computes the rate of net reflux of the exhaust gas which passes said exhaust air reflux valve from the engine rotational frequency detected like the above and an engine load, for example, a MAP, and the operating state of an exhaust air reflux valve, and flows into a combustion chamber for every operation period. While carrying out sequential calculation and memorizing the fuel-injection correction factor for every operation period based on it Since a dead time until exhaust gas passes an exhaust air reflux valve and flows into a combustion chamber is found, the calculation value of the operation period equivalent to a dead time is chosen and it considered that it was a fuel-injection correction factor in a current operation period Complicated count and an indefinite operational element can be reduced as much as possible, and though it is a simple configuration, in quest of the rate of reflux of the exhaust gas which flows into a combustion chamber with a sufficient precision, fuel oil consumption can be amended with a sufficient precision.

[0070] Furthermore, since the rate of reflux of a transient and the deflection of that at the time of a stationary presumed the rate of net reflux which flows into an engine combustion chamber paying attention to being a capacity rate paying attention to the flow characteristics of an exhaust air reflux valve, though it is a simple configuration, the behavior of exhaust gas can be grasped correctly. Moreover, since the capacity rate is used, the effect of the exhaust-gas temperature and exhaust gas pressure to capacity can be absorbed to remarkable extent, and presumed precision improves also in the semantics.

[0071] Drawing 11 is a flow chart similar to drawing 7 R> 7 which shows the 2nd example of this invention.

[0072] If a focus is set and explained to the point which is different from the 1st example, in S200, the rate of net reflux computed by S26 of the drawing 2 flow chart is stored in a ring buffer. And a dead time tau is searched with S202, and the rate of net reflux (this is called "the true rate of reflux") which corresponds by S204 is read, and the fuel-injection correction factor KEGRN is computed, and fuel oil consumption is amended by S206.

[0073] Thus, the engine rotational frequency and engine load with which the 2nd example was detected, For example, while computing and memorizing the rate of net reflux of the exhaust gas which passes said exhaust air reflux valve from a MAP and the operating state of an exhaust air reflux valve, and flows into a combustion chamber for every operation period Since a dead time until exhaust gas passes an exhaust air reflux valve and flows into a combustion chamber is found, the calculation value of the operation period equivalent to a dead time is chosen and it considered that it was the rate of exhaust air reflux which flows into a combustion chamber truly a current operation period Complicated count and an indefinite operational element can be reduced as much as possible, and though it is a simple configuration, it can ask for the rate of reflux of the exhaust gas which flows into a combustion chamber with a sufficient precision.

[0074] Drawing 12 is a flow chart similar to drawing 7 which shows the 3rd example of this invention.

[0075] If a focus is set and explained to the point which is different from the 1st example, it will progress to S304 through S300 thru/or S302, and the fuel-injection correction factor KEGRN which searches a ring buffer and is used from a predetermined dead time (for example, tau= 12) this time will be searched. That is, if the point which is the value which the dead time fixed is removed, a residual configuration and effectiveness are not different from the 1st example. Here, although a dead time serves as a different value for every engine with the distance to an exhaust air reflux valve and a combustion chamber etc., it shall ask through an experiment beforehand.

[0076] In addition, in the 3rd example, it cannot be overemphasized instead of the fuel-injection correction factor KEGRN like the 2nd example that the rate of net reflux may be stored in a ring buffer.

[0077] Drawing 13 is the flow chart which shows the 4th example of this invention, and is a flow chart which shows the calculation activity of fundamental-points fire stage thetaMAP.

[0078] Hereafter, if it explains, first, from the engine rotational frequency NE and MAP PBA current by S400, thetaMAP map for the time of exhaust gas un-flowing back will be searched, and it will ask for the fundamental-points fire stage at the time of exhaust gas un-flowing back (henceforth

"thetaMAPO"), and subsequently to S402 it progresses, and thetaMAP map for the time of exhaust gas reflux will be searched from the same parameter, and it will ask for the fundamental-points fire stage at the time of exhaust gas reflux (henceforth "thetaMAPT"). The property of thetaMAP map described above to drawing 14 is shown.

[0079] Subsequently, it progresses to S404 and fundamental-points fire stage thetaMAP is computed from the formula of illustration. According to the formula of illustration, since it is set to fuel-injection correction factor KEGRN=1 at the time of exhaust gas un-flowing back, fundamental-points fire stage thetaMAP serves as fundamental-points fire stage thetaMAPO at the time of un-flowing back. On the other hand, in the condition that the fuel-injection correction factor KEGRN and the fuel-injection correction factor KEGRMAP at the time of a stationary are in agreement, fundamental-points fire stage thetaMAP serves as fundamental-points fire stage thetaMAPT at the time of reflux. moreover, the fuel-injection correction factor KEGRN in the condition of not being in agreement with the fuel-injection correction factor KEGRMAP at the time of a stationary Fundamental-points fire stage thetaMAP serves as a value which carried out linear interpolation of between fundamental-points fire stage thetaMAPO at the time of un-flowing back, and fundamental-points fire stage thetaMAPT(s) at the time of reflux according to both ratio (even if behavior as actual fundamental-points fire stage thetaMAP shows with a broken line is shown at this time, since the difference with a straight line is minute, it is convenient).

[0080] Here, the fuel-injection correction factor KEGRN uses the value calculated in consideration of the dead time stated in the 1st example shown in drawing 7 , the 2nd example shown in drawing 11 , or the 3rd example shown in drawing 12 . Especially when based on the 2nd example shown in drawing 11 , the rate of net reflux may be buffered instead of (1-KEGRN), enabling free retrieval.

[0081] Furthermore, what is necessary is to make the fuel-injection correction factor KEGRMAP at the time of a stationary correspond to what buffers the fuel-injection correction factor KEGRN and the rate of net reflux in the 1st example shown in drawing 7 , the 2nd example shown in drawing 11 , or the 3rd example shown in drawing 12 , and just to make coincidence buffer it. Furthermore, when based on the 1st example shown in drawing 7 , or the 3rd example shown in drawing 12 , it is clear that you may buffer like the fuel-injection correction factor KEGRN in quest of the value of / (1-KEGRMAP) beforehand (1-KEGRN).

[0082] Moreover, when the value of / (1-KEGRMAP) exceeds 1.0 in that case (1-KEGRN), it restricts to 1.0 and it is necessary to make it the ignition timing of calculation value thetaMAP not exceed fundamental-points fire stage thetaMAPT at the time of reflux in the direction of a tooth lead angle, although the fuel-injection correction factor KEGRMAP at the time of a stationary may use the current value more simply calculated by the drawing 2 flow chart of the 1st example.

[0083] Since the fundamental-points fire stage was determined using the fuel-injection correction factor KEGRN computed like the above according to the inflow delay of an exhaust air reflux valve and reflux gas in the 4th example, also when exhaust air reflux actuation is performed, it can control correctly to the value of a request of ignition timing. After this fundamental-points fire stage performs amendment by water temperature, an intake-air temperature, etc., it is outputted. In addition, although the fundamental-points fire stage was directly determined using the fuel-injection correction factor KEGRN etc. in the above, the fundamental-points fire stage determined separately may be amended using the fuel-injection correction factor KEGRN etc.

[0084] In addition, although the rate of exhaust air reflux or the fuel-injection correction factor is memorized and it was made to choose according to a dead time, it chooses according to a dead time, and parameters, such as an engine rotational frequency required to compute the rate of exhaust air reflux or a fuel-injection correction factor, are memorized, and you may make it compute in the above by beginning the rate of exhaust air reflux, or a fuel-injection correction factor based on the selected value.

[0085] Furthermore, in the above, although atmospheric pressure was used by S10, S20, S22, etc. of drawing 2 , it may replace with it and exhaust gas pressure may be used.

[0086] Furthermore, in the above, although values LCMD, KEGRMAP, and QCMD and QACT were set up as a map value, you may ask by the operation each time.

[0087] Furthermore, in the above, although the thing of a negative pressure type was used as an exhaust air reflux valve, you may be an electric type.

[0088] Furthermore, although the MAP was used as a parameter which shows an engine load, an inhalation air content, throttle opening, etc. may be used.

[0089]

[Effect of the Invention] If it is in claim 1 term, complicated count and an indefinite operational element can be reduced as much as possible, and though it is a simple configuration, it can ask for the rate of reflux of the exhaust gas which flows into a combustion chamber with a sufficient precision.

[0090] If it was in claim 2 term, since it was made to grasp the behavior of exhaust air reflux gas from the flow characteristics of an exhaust air reflux valve, complicated count and an indefinite operational element can be reduced as much as possible, and though it is a simple configuration, the rate of exhaust air reflux of the net actually inhaled in a combustion chamber can be presumed with a sufficient precision.

[0091] Since it constituted so that said dead time might be found according to said internal combustion engine's operational status if it was in claim 3 term, it can ask for the rate of reflux of the exhaust gas which flows into a combustion chamber much more exactly.

[0092] If it is in claim 4 term, complicated count and an indefinite operational element can be reduced as much as possible, though it is a simple configuration, the rate of exhaust air reflux of the net actually inhaled in a combustion chamber can be presumed with a sufficient precision, and fuel oil consumption can be amended proper based on it.

[0093] If it is in claim 5 term, complicated count and an indefinite operational element can be reduced as much as possible, though it is a simple configuration, the rate of exhaust air reflux of the net actually inhaled in a combustion chamber can be presumed with a sufficient precision, and ignition timing can be amended proper based on it.

[0094] If it is in claim 6 term, it can ask for the rate of reflux or fuel-injection correction factor of exhaust gas which flows into a combustion chamber more simply.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the block diagram, showing the rate presumption equipment of exhaust air reflux of the internal combustion engine concerning this invention on the whole.
[Drawing 2] It is the flow chart which shows actuation of the rate presumption equipment of exhaust air reflux of drawing 1 .
[Drawing 3] It is the explanatory view showing the basic algorithm of rate presumption of exhaust air reflux concerning this invention, and is the explanatory view showing the property of capacity over the amount of lifts of the rate of exhaust air reflux used for the operation of the drawing 2 flow chart.
[Drawing 4] It is the explanatory view showing the delay of the real lift to the lift command value of an exhaust air reflux valve, and reflux gas.
[Drawing 5] It is the explanatory view showing the map property of the rate correction factor of exhaust air reflux at the time of the stationary used for the operation of the drawing 2 flow chart (rate correction factor of basic exhaust air reflux).
[Drawing 6] It is the explanatory view showing the map property of the lift command value used for the operation of the drawing 2 flow chart.
[Drawing 7] It is the subroutine flow chart which shows the calculation activity of the fuel-injection correction factor of the drawing 2 flow chart.
[Drawing 8] It is the explanatory view showing the configuration of the ring buffer used by the activity of the drawing 7 flow chart.
[Drawing 9] It is the explanatory view showing the map property of the dead time tau used by the activity of the drawing 7 flow chart.
[Drawing 10] It is a timing chart explaining the activity of the drawing 7 flow chart.
[Drawing 11] It is the flow chart similar to drawing 7 which shows the 2nd example of this invention.
[Drawing 12] It is the flow chart similar to drawing 7 which shows the 3rd example of this invention.

[Drawing 13] It is the flow chart which shows the 4th example of this invention.
[Drawing 14] It is the explanatory view showing the property of thetaMAP map used by the activity of the drawing 14 flow chart.
[Description of Notations]
1 Internal Combustion Engine Body
2 Inlet Pipe
5 Electronic Control Unit (ECU)
7 Absolute-Pressure Sensor
10 Crank Angle Sensor
16 Atmospheric Pressure Sensor
18 Exhaust Air Reflux Path
19 Exhaust Air Reflux Valve
25 Exhaust Air Reflux Device

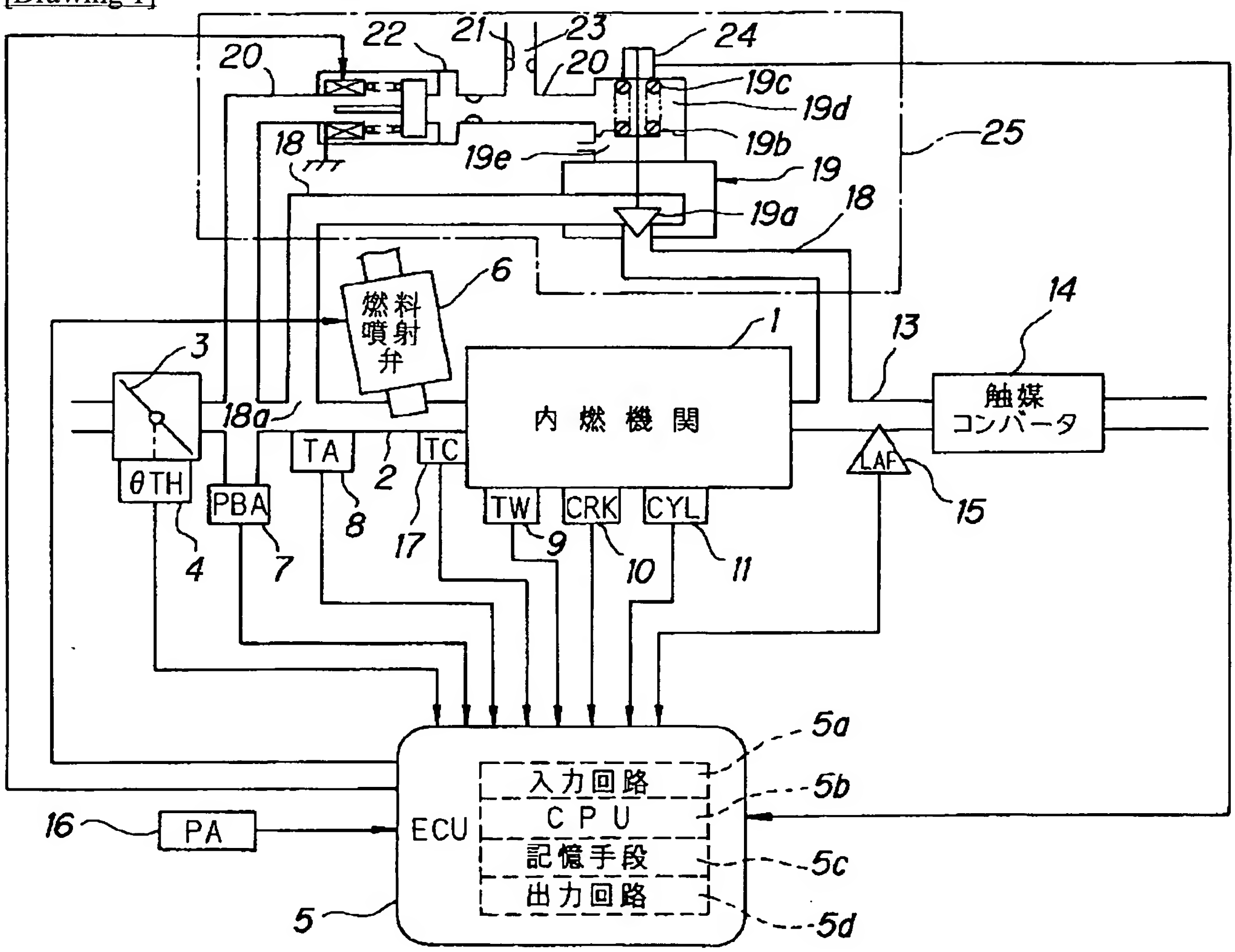
[Translation done.]

* NOTICES *

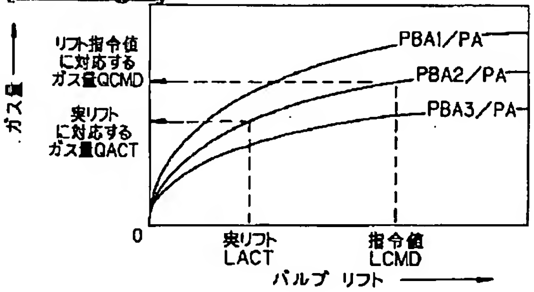
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

[Drawing 1]



[Drawing 3]



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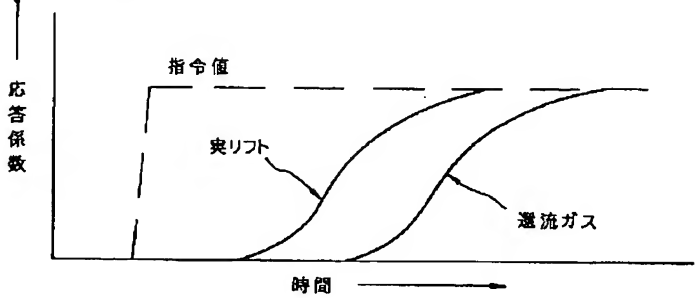
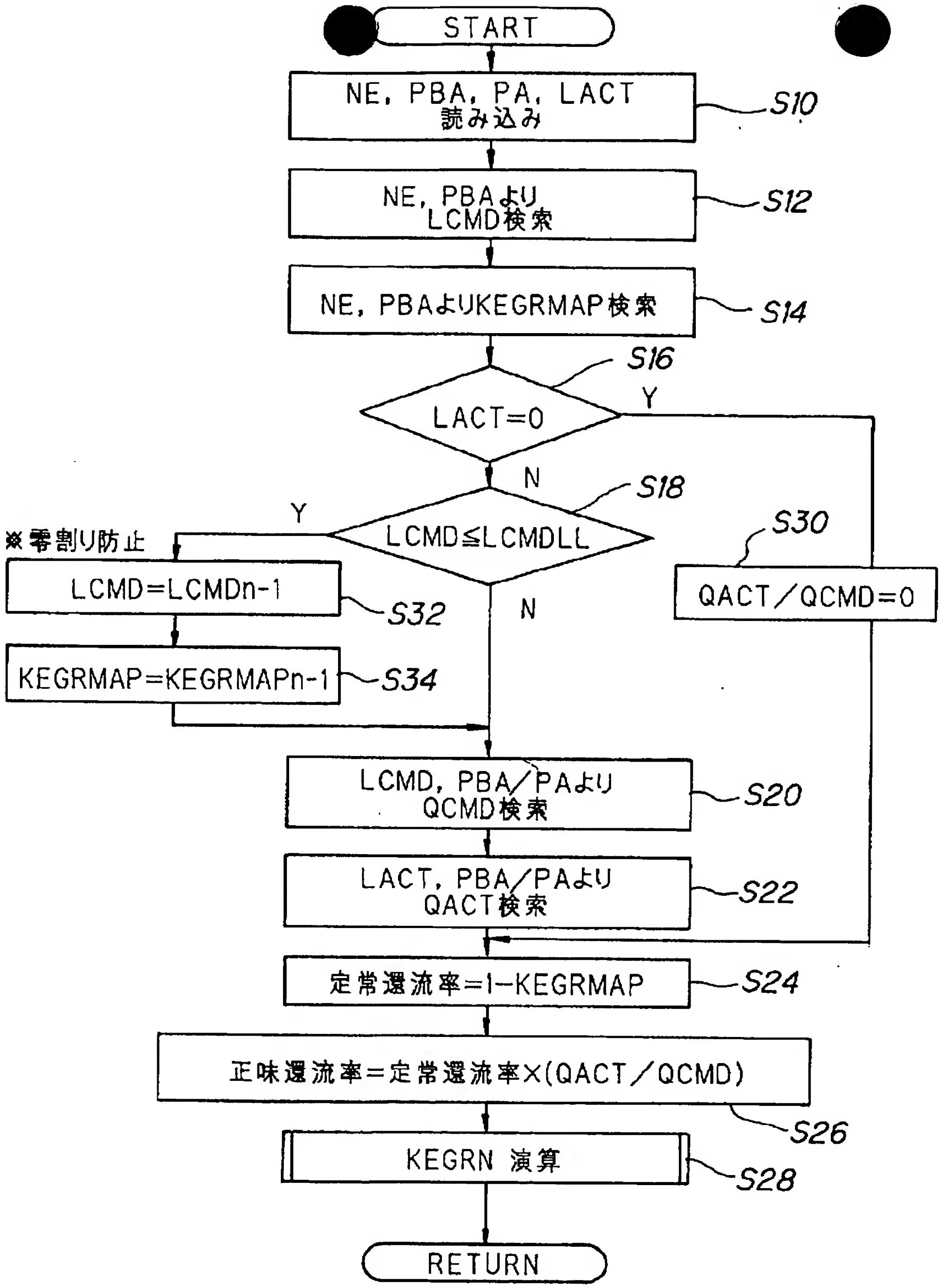


[Drawing 2]



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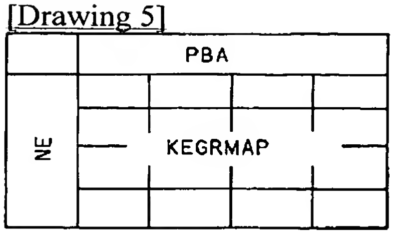

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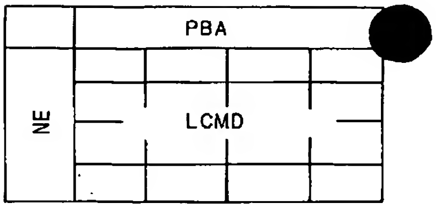
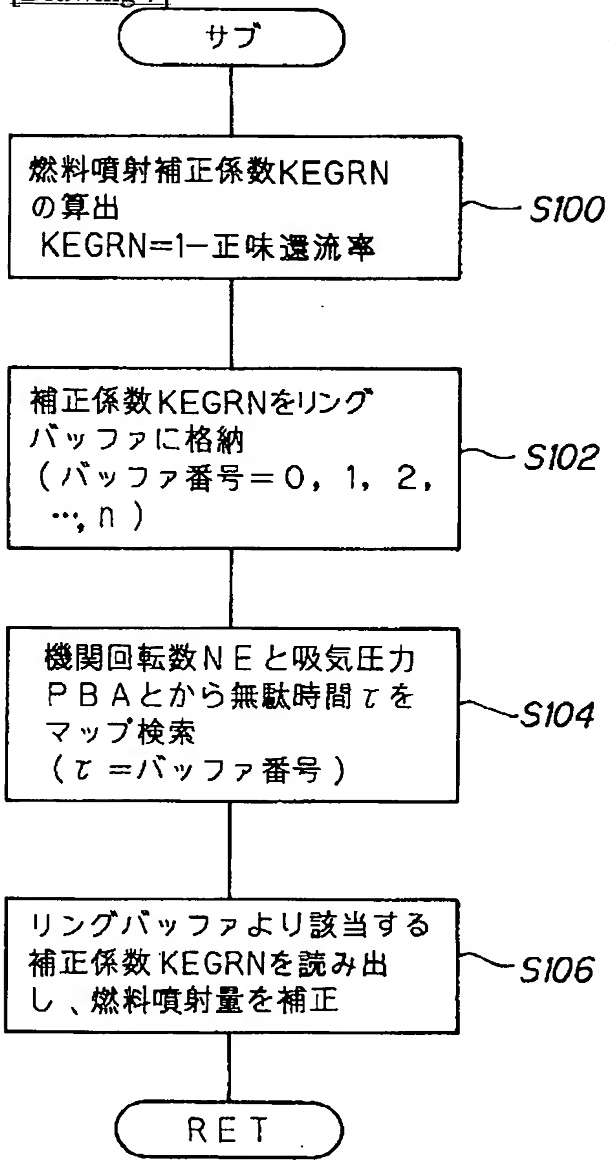
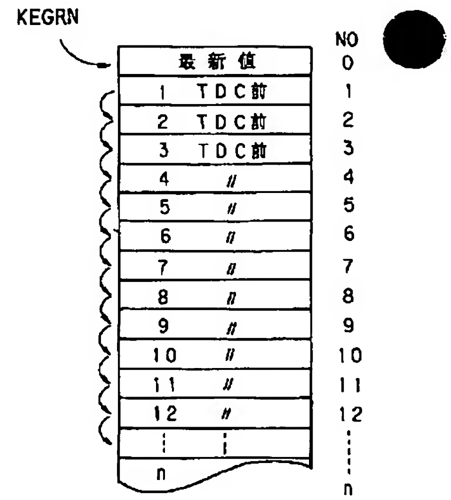


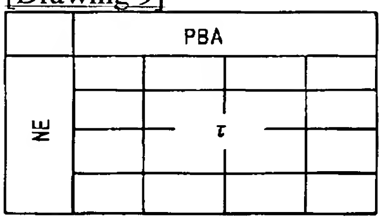
[Drawing 7]



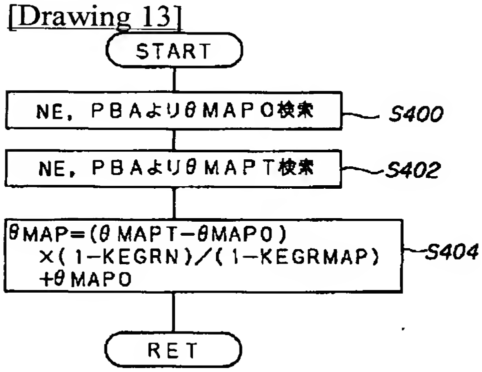
[Drawing 8]



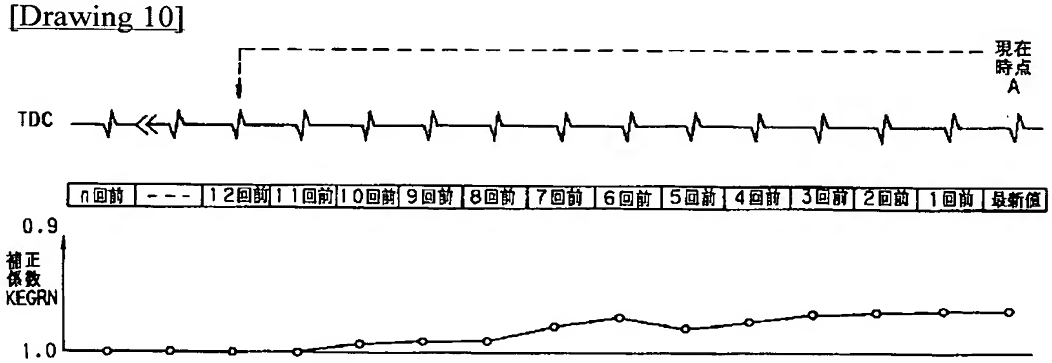
[Drawing 9]



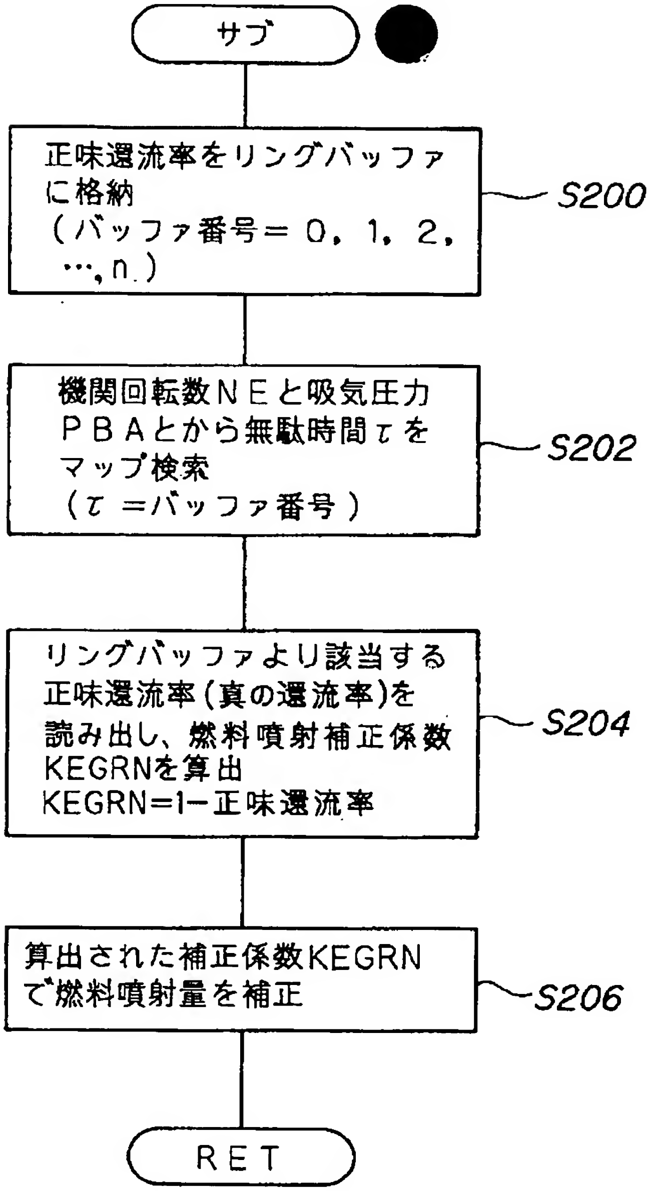
[Drawing 13]



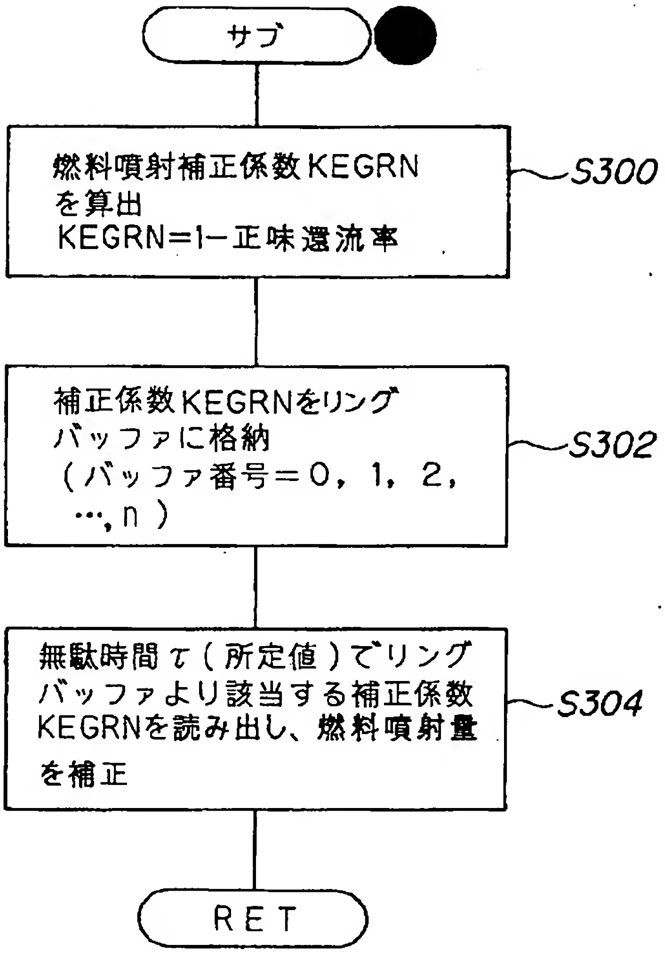
[Drawing 10]



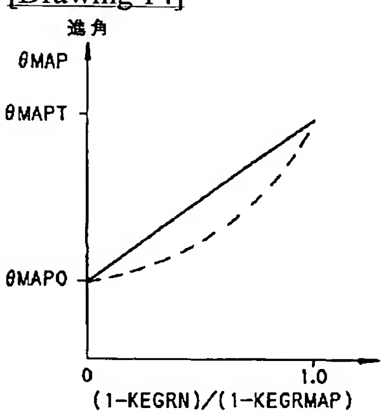
[Drawing 11]


サブ
正味還流率をリングバッファに格納
（バッファ番号＝０，１，２，…，n）
S200
機関回転数ＮＥと吸気圧力ＰＢＡとから無駄時間τをマップ検索
（τ＝バッファ番号）
S202
リングバッファより該当する正味還流率（真の還流率）を読み出し、燃料噴射補正係数KEGRNを算出
KEGRN=1−正味還流率
S204
算出された補正係数KEGRNで燃料噴射量を補正
S206
ＲＥＴ

[Drawing 12]



[Drawing 14]



[Translation done.]